B & Z LIBRARY

JUL 5 Rec'd

OHIO STATE UNIVERSITY
JUN 30 1960

Phytoseiid Mites (Acarina: Phytoseiidae)

Part I. Bionomics of Seven Species in Southeastern England

Part II. A Taxonomic Review of the Family Phytoseiidae, with Descriptions of 38 New Species

by

D. A. CHANT
Entomology Laboratory
Belleville, Ontario

THE CANADIAN ENTOMOLOGIST
Supplement 12
Accompanies Volume XCI, 1959

Supplements to the Canadian Entomologist

The first four articles in the series were numbered as supplements to individual volumes of the Canadian Entomologist, as follows:

Volume LXXXVII, Supplement 1, 1955
Volume LXXXVIII, Supplement 1, 1956
Volume LXXXVIII, Supplement 2, 1956
Volume LXXXVIII, Supplement 3, 1956

Subsequent articles are numbered in sequence, as follows:

Supplement 5, Accompanies Volume LXXXIX, 1957
Supplement 6, Accompanies Volume XC, 1958
Etcetera

Phytoseiid Mites (Acarina: Phytoseiidae)

Part I. Bionomics of Seven Species in Southeastern England

Part II. A Taxonomic Review of the Family Phytoseiidae, with Descriptions of 38 New Species

by

D. A. CHANT

Entomology Laboratory
Belleville, Ontario

THE CANADIAN ENTOMOLOGIST

Supplement 12

Accompanies Volume XCI, 1959

QL461
C21
Cop 2
1973-46

CONTENTS

PAGE

Part I. Bionomics of seven species in southeastern England 5

Introduction 5

Field Studies 7

Species investigated 7

Habitats and host ranges 7

Winter 8

Autumnal activity and overwintering sites 8

Winter mortality 9

Winter feeding 10

Spring activity 10

Summer 11

Development and behaviour of *T. pyri*, 1954 and 1955 11

Development and behaviour of other phytoseiid species, 1953-1955 14

Density-dependency of *T. pyri* on tetranychid mites 15

Predator-prey relationships 16

Competition between phytoseiid species 18

Insectary studies 19

Developmental times 19

Feeding habits 22

Immature mites 23

Adult mites 26

Influence of feeding habits on effectiveness of *T. pyri* as a predator of *Panonychus ulmi* (Koch) 29

Discussion on feeding habits 30

Distributions of predators and prey in apple trees 31

Distribution on surfaces of apple leaves 31

Interleaf distribution 32

Distribution on shoots and spurs 34

Effectiveness of *T. pyri* as a predator of *P. ulmi* 36

Discussion 39

Summary 44

PAGE

Part II. A taxonomic review of the family Phytoseiidae, with descriptions of 38 new species 45

Introduction 45

Phytoseiinae Berlese 48

Key to genera of the family Phytoseiidae 48

Typhlodromus Scheuten 48

Subgenus *Typhlodromus* Scheuten 49

Subgenus *Amblyseius* Berlese 66

Dubious species 103

Phytoseius Ribaga 105

Phytoseiulus Evans 108

Iphiseius Berlese 109

Asperoseius Chant 111

Proprioseius Chant 111

Seiulus Berlese 112

Typhloseiopsis DeLeon 113

Macroseiinae Chant, Denmark, and Baker 113

Macroseius Chant, Denmark, and Baker 113

Acknowledgments 114

References 115

Index to genera, species groups, and species in Part II 165

Phytoseiid Mites (Acarina: Phytoseiidae)

PART I. BIONOMICS OF SEVEN SPECIES IN SOUTHEASTERN ENGLAND

PART II. A TAXONOMIC REVIEW OF THE FAMILY PHYTOSEIIDAE, WITH DESCRIPTIONS OF 38 NEW SPECIES[1]

By D. A. CHANT[2]
Entomology Laboratory, Belleville, Ontario

Part I

BIONOMICS OF SEVEN SPECIES IN SOUTHEASTERN ENGLAND

INTRODUCTION

Phytophagous Acarina have increased in numbers in orchards throughout the world during the past 30 years until today they are considered pests of primary importance in many areas. The introduction and extensive use of insecticides and fungicides and the increasing employment of cultural practices such as manuring and pruning have probably favoured the increase, the former by destroying natural enemies and the latter by improving the quality of fruit trees and thus increasing their nutritive value to the pests. As a result, orchards have become highly artificial environments and insect and mite pests have become their most abundant fauna.

Chemical control of phytophagous mites in orchards is widely practised, but it is expensive and not always effective. Therefore, in recent years attention has been focused on the possibility of using biological control, and many enemies of phytophagous mites have been recorded and studied. No insect parasites have been found but predators include insects of the orders Coleoptera, Diptera, Neuroptera, and Hemiptera, and other species of mites with predacious habits (Newcomer and Yothers, 1929; Massee, 1932, 1953, 1954, 1955; Cottier, 1934; Gilliatt, 1935; Listo *et al.*, 1939; Pickett *et al.*, 1946; Collyer, 1949, 1953a, b, and c; Lord, 1949; Fleschner and Ricker, 1953; Putman, 1955).

A variety of predacious mites are known to occur in apple orchards throughout the world (Cottier, 1934; Nesbitt, 1946, 1951; Garman, 1948; Collyer, 1949, 1953a and b, 1956; Lord, 1949; Clancy and Pollard, 1952; Muma, 1955a; Herbert, 1956), but interest has centred on those of the family Phytoseiidae Berlese, 1916. The species of this family that occur most commonly in orchards are of the genus *Typhlodromus* Scheuten, 1857, but representatives of *Phytoseius* Ribaga, 1902, are sometimes also present. Members of these two genera are discussed in this paper. Their synonymies were discussed in detail by Nesbitt (1951) and it suffices to say here that the generic names *Seius* Koch, 1836, and *Amblyseius* Berlese, 1914, are synonymous with *Typhlodromus*, and until 30 years ago most

[1]Contribution No. 3862, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada; Part I from a thesis approved for the Ph.D. degree in the University of London.
[2]Entomologist.

of the complex of presently recognized species were loosely referred to as *S. pomi* Parrott, 1906.

Interest in these mites from an economic rather than a taxonomic point of view was first shown by Parrott *et al.* (1906). They reported *S. pomi* as of value in controlling *Eriophyes pyri* (Pgst.), the pear leaf blister mite. Since that time there have been many references to these predators feeding on eriophyid and tetranychid mites of economic importance, and in 1935 Gilliatt reared a few individuals in Eastern Canada and obtained general information on their feeding capacities. In 1948 Garman revised several phytoseiid genera and used certain morphological characters for specific determination that make it possible for field workers to identify their own material. Nesbitt (1951) carried this a step further by revising the subfamily Phytoseiinae on the basis of Garman's system; he also stated that phytoseiids are one of the most important factors in the control of tetranychids throughout the world. These two papers stimulated interest in phytoseiids and references to the possible effects of these mites on pest species are becoming numerous.

In recent years Mr. A. D. Pickett, Science Service Laboratory, Kentville, and his staff investigated the natural control of orchard pests in the Annapolis Valley in Nova Scotia. After more intensive studies than had previously been attempted, they also concluded that phytoseiids are one of the most important factors in the control of phytophagous orchard mites (Lord, 1949; Herbert, 1953). In England, Dr. A. M. Massee and Miss E. Collyer, East Malling Research Station, Kent, conducted similar work and concluded that, whereas in that country these predators are not the most important enemies of phytophagous mites, they may be effective under certain conditions (Collyer, 1953a; Massee, 1954; Collyer and Kirby, 1955). The evidence presented by all these workers is, however, largely circumstantial.

Most work with these mites was largely concerned with recording their predacious habit and reporting apparent correlations between predator and prey populations. Some of these conclusions may have been misleading as it is dangerous to claim correlations between insect and mite populations when few details of the biology of the organisms, or of the mechanism of their interactions, are known. Apparent correlations may well be caused not by the influence of one species on another but by two independent organisms reacting in opposite ways to other environmental factors.

Phytoseiid mites have been regarded as valuable agents of biological control for almost 50 years, but our knowledge of their bionomics is remarkably slight. Detailed biological information has been obtained for only three species (*T. cucumeris* Oudms., *T. pyri* Scheuten (= *tiliae* Oudms.), and *T. fallacis* (Garman)), and these were studied under laboratory conditions (MacGill, 1939; Ballard, 1954; Herbert, 1956). In the field, general observations on their bionomics have been made, but no detailed studies have been undertaken and virtually nothing is known regarding their existence in environments other than orchards. The latter is of particular interest because, to understand the behaviour of these mites in artificial environments, we should first have information on these matters in natural habitats. This paper is a contribution to this necessary background of knowledge.

The work reported in this part of this paper was done at the East Malling Research Station, Kent, England, from 1952 to 1955. It deals with the bionomics of several species that were abundant in England, under both insectary and field conditions: with their life-histories and development, their feeding habits, their distribution within the habitats in which they live, and their interrelations with other mites, mostly phytophagous species. The studies were not confined to

orchards, the purpose being to gather information on these predators in as many habitats as possible within the time available. When studies were conducted in orchards, only apple trees were used. *T. pyri* and *T. finlandicus* (Oudms.) are frequently emphasized because they are the most commonly occurring species of predacious mites in English apple orchards and are among the most generally abundant in the study area.

Field Studies

Species Investigated

A list of the phytoseiid species known to occur in southeastern England was given by Chant (1956). Of these, this paper deals only with the following: *T. pyri* Scheuten, *T. finlandicus* (Oudms.), *T. aberrans* Oudms., *T. umbraticus* Chant, *T. bakeri* (Garman), *Seiulus simplex* Chant, *Phytoseius macropilis* (Banks). The species studied in detail were chosen for convenience: either they were very common or they occurred on a species of host plant that was accessible and easy to sample.

Habitats and Host Ranges

Phytoseiids inhabit living plants and within that limit are probably the most ubiquitous mites in southern England, though their numbers are usually small. During 1952 and 1953 more than 300 samples of soil were examined from a variety of localities in which these mites were known to be present on the flora. Only two phytoseiids were obtained from the samples: both were *P. macropilis*, and they may have fallen with falling leaves.

The following are notes on the habitats and host-plant ranges of the species investigated.

T. pyri.—Commonest species in southeastern England. Found during this study on 30 species of plants, both herbaceous and woody; frequently associated with other mite species. Usually on foliage throughout the summer.

T. finlandicus.—Common. Plum, oak, and unsprayed apple apparently the favoured host plants though large numbers found occasionally on *Rubus* spp. Found during this study on 22 species of plants, preferring trees and shrubs, especially those with glabrous leaves, frequently in the absence of other mite species.

T. bakeri.—Common, though not previously recorded in England. Entirely bark-inhabiting and usually associated with mites of the family Tydeidae and others. Probably feeds on algae and fungi as well as on mites. Found during this study on 18 species of plants.

T. aberrans.—Abundant during this study on hazel, *Corylus avellana* L., and medlar, *Mespilus germanica* L., frequently in the absence of other mite species. Never found reproducing on plants other than these two. Rarely found on other plants, where its occurrence is probably accidental.

T. umbraticus.—Usually found on herbaceous plants but occasionally on trees. On bramble throughout the year, in large numbers in autumn. Entirely leaf-inhabiting in summer, frequently in the absence of other mite species. Found during this study on 12 species of plants.

Seiulus simplex.—Locally abundant during this study, preferring oak, *Quercus robur* L., but occasionally found on beech, *Fagus sylvatica* L. Leaf-inhabiting during the summer and usually associated with other mite species.

Phytoseius macropilis.—Common, leaf-inhabiting in summer, and frequently associated with other mite species. Found during this study on 12 species of plants.

Remarks.—Only *T. pyri* was commonly found on sprayed, well-kept apple trees, though *T. finlandicus* and *P. macropilis* occurred occasionally. On unsprayed, neglected trees nine species in approximate order of abundance as follows were found: *T. finlandicus*, *T. pyri*, *T. bakeri*, *P. macropilis*, *T. tiliarum*, *T. rhenanus*, *T. umbraticus*, *T. masseei*, and *T. soleiger*. *T. finlandicus* was many times more abundant than *T. pyri* on unsprayed trees.

Routine winter washing was practised in English orchards almost without exception until recently. Frequent sprays of lime-sulphur are applied as a fungicide in spring and summer, and usually other substances such as nicotine, DDT, lead arsenate, and an acaricide are also applied. Under these conditions phytoseiids are rarely present. *T. pyri* may be found in small numbers where only winter washes and fungicides are applied. Because this is the only species that occurs regularly in commercial orchards in Kent and Essex, it is the only species of possible value to the fruit grower at present. Other species that occur in unsprayed orchards might colonize commercial plantations if spray programs were modified to eliminate the more harmful chemicals.

WINTER

Several authors have expressed the belief that most phytoseiids spend the winter under bark on trees, though some might leave the trees to shelter in soil or orchard debris (Gilliatt, 1935; Garman and Townsend, 1938). Those on the trees were said to emerge on warm winter days to feed on the overwintering eggs of tetranychids. These beliefs were mostly speculative, however, and rarely based on observation.

Autumnal Activity and Overwintering Sites

In 1953 a population of phytoseiids was studied during leaf-fall; it was thought some mites might reach the ground on falling leaves, where they would then overwinter. This study was done with unsprayed, neglected apple trees where *T. finlandicus* was abundant and *T. pyri* and *T. umbraticus* were also present. Frequent collections of leaves were made as follows: green leaves and yellowed leaves from the trees, yellowed leaves caught while falling, and recently fallen leaves. Table I shows that the numbers of the species present that reached the ground on falling leaves were not appreciable; the mites largely vacated yellowing leaves and moved either to leaves that remained green (a slight increase in numbers occurred on these during the period) or to the wood in preparation for overwintering.

In 1954, similar observations made with *T. pyri* alone on unsprayed apple in Kent showed that when 90 per cent of the leaves had fallen most of the mites had moved to the twigs and branches.

Apparently most phytoseiids are not carried to the ground on falling leaves. It was necessary also to determine whether they leave the trees to overwinter on the ground by walking down the trunks. In the autumns and winters of 1952 and 1953 collections of bark were examined from the lower parts of unsprayed apple trees, but phytoseiids were rarely found. This strongly suggested, therefore, that phytoseiids overwinter on the host trees. As mentioned above, only two mites were obtained from more than 300 soil samples (150 cc. each) examined during these years.

In the winter of 1953 many large samples of twigs and bark from various trees were examined. Certain branches yielded large numbers of mites whereas others were barren. Few mites spent the winter merely under loose bark; they preferred the deep crevices surrounding old scars, canker wounds, and especially the

splintered ends of dying twigs. Only adult females were taken during the winter, as the males die at the end of the summer. Few leaf-inhabiting phytoseiids were found on the trunks of trees, possibly because an abundance of suitable sites was available on the larger branches. Only *T. bakeri* was common on the trunks, where this species also spends the summers. These observations apply not only to fruit trees: all species of phytoseiids that inhabit woody plants in southeastern England were found to overwinter in crevices on the aerial parts of the trees.

TABLE I.

Total numbers of phytoseiids found on apple leaves in autumn, Penlan Hall, Essex, 1953.

Collection period	Type of leaf	Number of leaves examined	Phytoseiids
October 8	Green on trees	60	54
to	Yellow on trees	60	2
	Yellow falling	60	0
October 15*	Yellow on ground	60	7
October 16	Green on trees	40	49
to	Yellow on trees	40	7
	Yellow falling	40	4
October 23	Yellow on ground	40	3

*On October 15, 50 per cent, and on October 23, 95 per cent of leaves had fallen.

This overwintering habit may influence the importance of these predators in commercial orchards; suitable overwintering sites are usually not numerous on well-kept fruit trees, so that the phytoseiids are frequently not abundant until late in the summer. Even when deep within their winter retreats these mites are apparently damaged by winter sprays, but otherwise only those that find suitable retreats on the trees are available for reproduction the following season.

In the autumn, phytoseiids that inhabit annual herbaceous plants move to evergreen plants, such as *Ranunculus* sp., bramble, and nettle, *Urtica dioica* L., where large numbers may be found in late summer and autumn, sometimes in aggregations of 50 to 60 per leaf.

Winter Mortality

No information on this subject was found in the literature, though it may be important because it must largely determine the density of the spring population, and therefore perhaps influence the effectiveness of these mites as predators.

Phytoseiids that overwinter on herbaceous evergreens can be counted to determine mortality; the immediate mortality is assessed from the numbers of dead individuals on the leaves, and any reduction during the winter can be followed. To assess this reduction accurately a correction factor is necessary because the number of leaves on the plants is reduced by frost, and the surviving mites crowd on to the remaining leaves. Therefore, winter mortality of leaves must be estimated and the surviving population of mites must be expressed in terms of the mites per total leaves. Species that overwinter on deciduous trees cannot be counted directly. Instead, the densities early and late in the winter can be compared to obtain an estimate of mortality.

Observations by these two methods during the winters of 1953 and 1954 in several localities showed that among the species examined mortality was high — approximately 90 per cent for *T. umbraticus* and *T. bakeri*. *T. pyri* was sampled only until February because it was to be used for studies the following summer and it was undesirable to dilute the populations; even so, up to February the mortality suffered by this species was 54 per cent. Further isolated records were taken for these and other species, and in every instance a mortality greater than 90 per cent was indicated.

Another method of calculating total mortality was used to obtain a more accurate estimate for *T. pyri* in 1954 and 1955. This was to relate the number of mites per total number of leaves on apple in autumn to the number per total number of leaves in May, before reproduction. This was done on five apple trees on which the mites overwintered almost entirely in bands of sacking placed around the trunks to protect the trees from their supports. Before leaf-fall in October, 1954, there was an average of 133 *T. pyri* per 100 leaves; in May, 1955, only three. In October, 1954, there was an average of 990 leaves per tree, whereas in May, 1955, there was an average of 1,025, and therefore the actual reduction in mites was 97 per cent.

These observations indicate that the winter mortality of phytoseiids in south-eastern England is high, probably 80 to 90 per cent. This may be a major factor that limits the abundance of these mites in this area, though it is not density-dependent because there is probably little competition for overwintering sites except on cultivated trees. This is discussed further in a later section.

Winter Feeding

Several authors (e.g., Gilliatt, 1935; Collyer, 1953a) stated that phytoseiids on apple trees become active on warm winter days and feed on the winter eggs of *Panonychus ulmi* (Koch), the European red mite. However, on trees where overwintering sites contained both phytoseiids and other mite species that provide food, no evidence that feeding had occurred was found. To test the matter further with regard to *P. ulmi*, a small sprayed orchard was examined in 1954 in an attempt to relate the numbers of winter eggs of *P. ulmi* from which the contents had been sucked by predators (Collyer, 1953a) with the numbers of *T. pyri* overwintering. Differential populations of this predator were available after different summer treatments. The total of winter eggs on the first inch of current-year wood were counted on 10 twigs from each tree after the twigs had been examined and *T. pyri* removed. The numbers of sucked eggs could not be related to the density of *T. pyri* during the winter or during the previous summer. The eggs were probably destroyed by predacious insects that were uniformly abundant on all the trees in autumn.

Feeding experiments were conducted in the laboratory. Specimens of the phytoseiids common in the study area were collected from overwintering sites, brought to the warm laboratory where they became active, and offered numerous winter eggs of *P. ulmi* as food. No feeding occurred and the mites soon died of starvation. When eggs were damaged and their contents exuded, the mites fed readily and lived apparently normally, but they did not pierce the shells of intact eggs.

Spring Activity

Phytoseiids emerge from their overwintering sites with the advent of warm weather in spring. In some years they emerge before the buds of the host trees

are fully open, whereas in others the leaves are already developed. They usually arrive on the developing leaves before the winter eggs of *P. ulmi* hatch, and before other mite species arrive; therefore, animal prey is not available. Leaf-inhabiting phytoseiids roam over the branches and twigs near the overwintering sites after they emerge, exhibit interest in the buds and leaflets, and usually settle on developing leaves before laying eggs. Protein is probably necessary for egg laying, but frequently there is no animal food at this time of year and plant proteins are available in quantity only from pollen grains in the blossoms.

An experiment was conducted in the spring of 1955 to determine the suitability of pollen as food for gravid *T. pyri*. The number of mites used was small and pollen grains were plentiful for only a few days, but the results seem significant. Ten mites received water and apple pollen grains, and 10 received only water. When feeding, the mite grasps a grain with its chelicerae, sucks the contents, and discards the empty covering. The mites that received pollen laid 10 eggs over a period of five days, whereas those with only water laid none in the same period. On the fifth day all those with only water had died, whereas those with pollen were still active. Pollen, therefore, evidently provides food that enables female phytoseiids to lay eggs early in the year before other types of food are available, and it may also prevent starvation.

SUMMER

Development and Behaviour of *T. pyri*, 1954 and 1955

To investigate the ecology of phytoseiids in the field, *T. pyri* was selected for intensive study in 1954 and 1955. In a small orchard of unsprayed Lane's Prince Albert apple trees at East Malling, 10 trees were chosen in 1954. In 1955 it was impossible to use six of these trees, and six adjacent ones were substituted; comparable samples showed that the two groups did not differ in mite population. Leaves were collected every three to four days when the weather permitted, 10 leaves being picked at random from each tree. In 1954 a mite brushing machine (Henderson and McBurnie, 1943; Chant and Muir, 1955; Morgan *et al.*, 1955) was used but in 1955 each leaf was examined microscopically, and the eggs and mites recorded. Late in each season the sample size was reduced to five leaves per tree because of the smaller number of leaves available.

Figs. 1 and 2 show the component parts of the populations of *T. pyri* for the two years. The mites emerged from overwintering in April but the leaves were not sufficiently well developed to sample until May. Shortly after this, during the pink bud stage of flower development, the first eggs were laid. The eggs recorded in the two years provide the best index to the number of generations. In 1954 the three distinct peaks indicate the occurrence of three complete generations; the longer period of egg production associated with the third peak and the bimodal curve for the adults suggest the possibility of a partial fourth generation. In 1955 the number of generations was less obvious but on the same basis there appear to have been three complete and a nearly complete fourth. In 1954, in the adults the distinction between generations was largely obscured, partially by overlapping (immature stages are transient but, mortality excepted, the number of adults is cumulative), and probably also by predation, which may have reduced the numbers of second-generation adults. In 1955 the third- and fourth-generation adults almost entirely overlapped, but the magnitude and duration of the increase in late summer again suggested the presence of four generations.

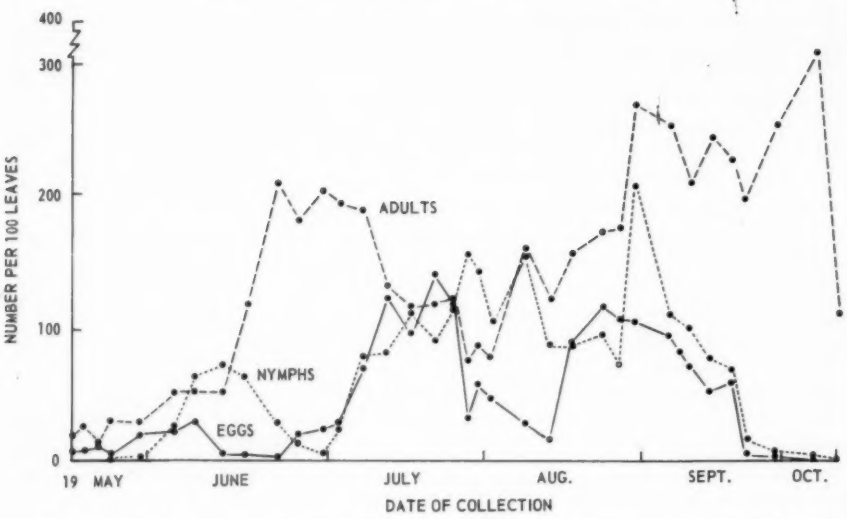


Fig. 1. Numbers of eggs, nymphs, and adults of *Typhlodromus pyri* on apple leaves during the summer of 1954.

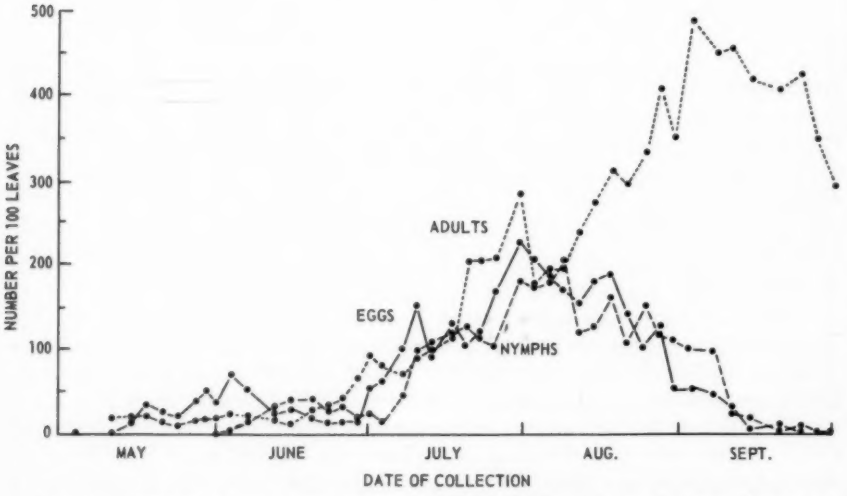


Fig. 2. Numbers of eggs, nymphs, and adults of *T. pyri* on apple leaves during the summer of 1955.

The development of the populations in the two years differed: in 1954 the first generation was large but little increase followed; whereas in 1955, though the first generation was small, the population increased throughout the season and eventually attained larger numbers than in the preceding year. Food was not scarce in either year, but in 1954 the weather was cold and wet and this, though it probably slowed development and maintained a separation between generations, may have caused the "collapse" in population that occurred in mid-

summer. In 1955 a warm spring when many eggs were laid was followed by cold weather, which may have retarded nymphal development and resulted in a small number of first generation adults. Mid- and late-summer were hot, development was accelerated, the generations overlapped. The data suggest that three is the minimum and four the maximum number of generations for this species in southeastern England.

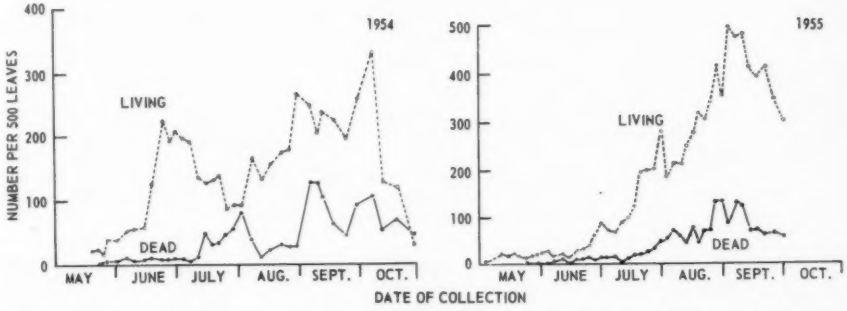


Fig. 3. Numbers of living and dead adults of *T. pyri* on apple leaves during the summers of 1954 and 1955.

Fig. 3 shows the numbers of living and dead adults found on the leaves each year. Some dead undoubtedly fell from the leaves prior to collection, though others may have remained for many days. For this reason quantitative conclusions would be misleading though qualitative ones are probably valid. Dead nymphs were not recorded because they are delicate and easily blown from leaves and any counts would have been highly variable and unreliable. In 1954 the first and second peaks in numbers of living adults were followed by peaks for dead, indicating that the adults of these generations lived a short period. In 1955 the peaks for first- and second-generation adults were accompanied by slight peaks in mortality but the relationship was not as evident as in 1954 and this suggests that in 1954 a large number of adults died soon after maturation whereas in 1955 longevity was greater. Later in 1955, when the generations overlapped, no such relation between numbers of living and dead was evident. The numbers of dead were approximately equal in the two years but in 1954 the incidence of death in early summer was greater than in 1955, which might account for the difference in population development discussed above. It was as if in 1954 the population trends were determined by mortality, whereas in 1955 the reverse was true and the numbers of dead were merely a reflection of the numbers of living present. Predacious mirids and anthocorids were probably the greatest cause of mortality; these insects were abundant each year and some dead mites appeared to have been sucked. These predators fed readily on *T. pyri* and other phytoseiids in the laboratory.

Figs. 4 and 5 show the numbers of adults of each sex of *T. pyri* recorded in the two summers. In 1954 (Fig. 4) the females outnumbered males 2.2:1 and in 1955 (Fig. 5) 2.0:1, indicating that the sex ratio in the field is approximately 2:1. No obvious differences between the rates of development of the sexes were observed in any generation and the longevity of the males in the summer apparently did not differ from that of the females. The males die at the end of each season, though occasionally they may be found prior to death in an overwintering site

in autumn. The males frequently attend a female deutonymph and wait for her to moult; three were seen attending one female. Females containing fully formed eggs rarely copulate and one mating is sufficient to last throughout the fertile life of a female, though more may occur. Parthenogenesis does not occur.

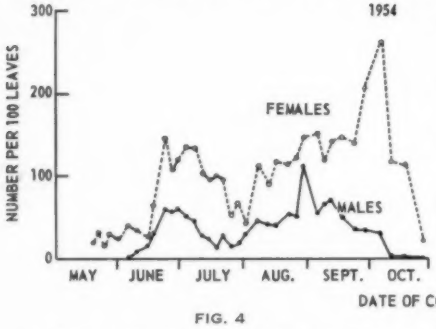


FIG. 4

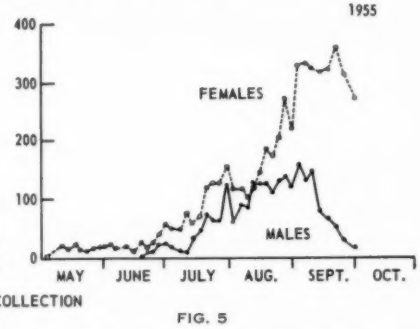


FIG. 5

Fig. 4. Numbers of adult males and females of *T. pyri* on apple leaves during the summer of 1954.

Fig. 5. Numbers of adult males and females of *T. pyri* on apple leaves during the summer of 1955.

Development and Behaviour of Other Phytoseiid Species, 1953-1955

In addition to *T. pyri, T. finlandicus* in 1954 and three other species of phytoseiids in 1955 were studied in the field. These were selected for study because they were abundant in the East Malling district and could be collected easily. They were: *T. aberrans* on hazel and *T. umbraticus* on blackberry at one locality (Newgates Shaw, East Malling Research Station); *S. simplex* on oak and *T. umbraticus* on blackberry in Oaken Wood, Kent; and *T. finlandicus* on unsprayed apple at Ulcombe, Kent. Weekly collections made from May to September were brought to the laboratory and examined immediately. The smallness of sample size resulted in large numerical differences between samples that sometimes obscured developmental trends. However, expressing the frequencies of the developmental stages as percentages of total populations suggested the numbers of generations. These are shown in Table II, together with the sex ratios observed.

TABLE II.

Numbers of generations and sex ratios of five species of Phytoseiidae, 1955.

Species	Number of generations	Sex ratio	
		females	males
T. pyri	3–4	2.0	1
T. finlandicus	2–3	2.1	1
T. aberrans	3	2.6	1
S. simplex	3–4	2.4	1
T. umbraticus	2–3	5.6	1

Fluctuations in the abundance of the adults of three species provided a slight indication of the numbers of generations, but with *T. finlandicus* no such indication was apparent. The mortality of *T. finlandicus* is shown in Fig. 6; it was small early in the year and therefore the numbers of adults were cumulative. For generations to be distinct there must be numerical fluctuations, but Fig. 6

shows that in this instance such fluctuations were absent and the numbers of adults increased steadily during two generations until the end of July, when the most effective predacious insects are known to hatch. Then the numbers of adults decreased, and this continued until the predators became inactive. This is in contrast with the graph for *T. pyri*, for which, as already shown, periods of increased mortality sometimes followed peaks in abundance, and the population then declined and was not cumulative. The other species tended to resemble *T. pyri* in this regard, though the mortality of *T. umbraticus* was small and the distinction between generations less evident in the adults.

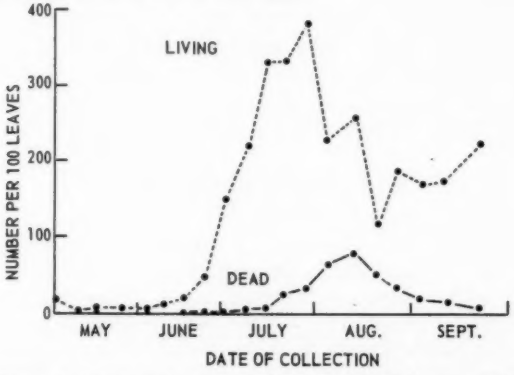


Fig. 6. Numbers of living and dead adults of *Typhlodromus finlandicus* on apple leaves during the summer of 1955.

Density-dependency of *T. pyri* on Tetranychid Mites

The importance of density-dependency in predator-prey relationships has often been emphasized (Solomon, 1949; Nicholson, 1954; Lack, 1954). To "control" a prey, the effect of a predator must increase as the prey increases in density, otherwise, the prey population is free to fluctuate in the presence of a stable mortality factor. Density-dependency can be achieved in two ways: by a numerical increase of predators that follows either immigration or increased reproduction and survival as a result of abundant food; or by an increased food consumption per individual when prey is abundant. The second method is discussed in a later section.

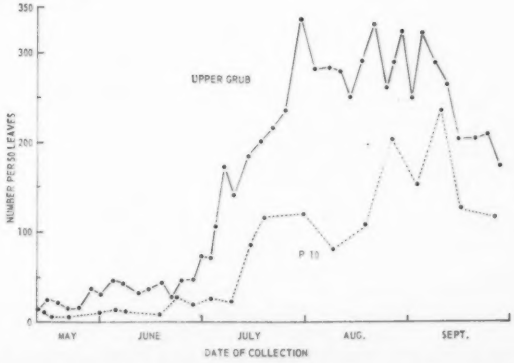


Fig. 7. Numbers of all stages of *T. pyri* in orchard with no tetranychids (Upper Grub) and in one with an abundance of tetranychids (P10) during the summer of 1955.

An opportunity to investigate the possibility that *T. pyri* is numerically dependent on tetranychid mites was afforded in the orchard that was used for the field studies on *T. pyri* described above (i.e., Upper Grub). The development of the population here was compared with that in another orchard of the same variety (Lane's Prince Albert) at East Malling. No toxic summer sprays were applied in either orchard. In the first orchard, Upper Grub, where virtually no tetranychid mites were present, *T. pyri* increased from 16 per 50 leaves in May to 320 per 50 leaves in September (Fig. 7). In the second orchard, P10, where *P. ulmi* was abundant, *T. pyri* increased from 12 per 50 leaves in May to 230 per 50 leaves in September. In this orchard the mean number of leaves per tree increased from 1,025 in May to 1,240 in September, and thus the actual increase in *T. pyri* was 23 times when corrected for habitat expansion. A similar tree increment being assumed in the first orchard, the actual increase of *T. pyri* was 24 times. Therefore, there was no obvious difference between the rates of increase of *T. pyri* where *P. ulmi* was abundant and where *P. ulmi* was virtually absent.

Predator-prey Relationships

During the above studies, observations were also made on the phytophagous mite species present in each location. *T. aberrans* was associated with the eriophyid *Phytoptus avellanae* Nal. and an unidentified species of *Tetranychus*, *S. simplex* with *Phytoptus quercinus* (Canestrini), *T. finlandicus* and *T. pyri* with the eriophyid *Vasates schlechtendali* (Nal.), and, in one location, *T. umbraticus* with *Eotetranychus carpini* Oudemans. In the other location where *T. umbraticus* was studied no other species of mites were found.

Studies on the interactions between phytoseiids and phytophagous mites that were reported by Gilliatt (1935), Kuenen (1947), Lord (1949), Clancy and Pollard (1952), Collyer (1953a and b), Herbert (1953), Collyer and Kirby (1955), Muma (1955a), and others have demonstrated interesting correlations between the numbers of predators and prey. These workers have frequently shown that an increase in predators is accompanied by a decrease in prey, and vice versa. However, observance of correlations is not proof of cause and effect; such apparent relations may in reality be the expression of two separate biological phenomena. For example, phytophagous mite populations usually decline spectacularly in the early autumn when the mites leave the foliage to overwinter,

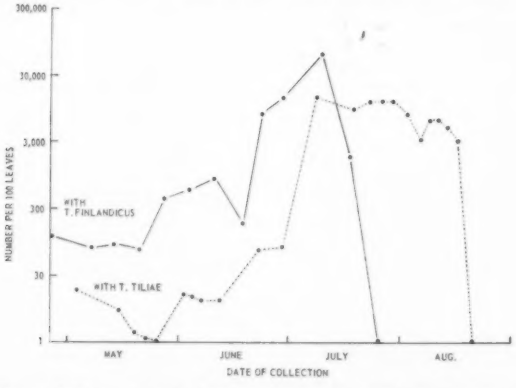


Fig. 8. Numbers of *Vasates schlechtendali* in orchard where *T. pyri* (= *T. tiliae*) was abundant (100-leaf sample) and in one where *T. finlandicus* was abundant (50-leaf sample) during the summer of 1955.

whereas phytoseiids may continue to increase and to remain on the foliage until late September or October, long after the pest species has departed. Thus, apparent correlations may be completely unrelated.

In the present study, the effects of *T. pyri* and *T. finlandicus* on the population characteristics of the eriophyid mite *V. schlechtendali* in 1955 were compared. Fig. 8 shows that when the eriophyid was associated with *T. pyri* it persisted until late in August, its normal time for seeking overwintering quarters; with *T. finlandicus*, however, it disappeared one month earlier. In the orchard with *T. pyri* eriophyids were abundant in September, hibernating in bud scales and under loose bark, whereas in the orchard with *T. finlandicus* they were scarce in these places. Thus, *T. finlandicus* apparently almost exterminated the eriophyid whereas *T. pyri*, though it may have reduced the population, did not change its usual characteristics and allowed a larger number to survive. An experiment described below showed that an adult phytoseiid may eat as many as 80 eriophyids per day, with an average of about 30 per day. In the orchard with *T. finlandicus*, *V. schlechtendali* reached a density of 72,000 per 100 leaves whereas the phytoseiid reached a density of 400 in active stages at the same time. One week later the eriophyid density had dropped by 68,000. Four hundred *T. finlandicus* each destroying an average of 30 eriophyids each day would destroy 84,000 in one week, and thus this predator was easily capable of causing the observed reduction. *T. pyri*, with a density approximately the same as *T. finlandicus* and the same capacity for eriophyids, caused no such reduction. If, indeed, this is what took place, the difference in efficiency of the two predacious species may be explained by their different distributions on apple leaves. It will be shown in a later section that *T. pyri* inhabits the mid-ribs and larger veins of apple leaves and is rarely found on the laminae, whereas *T. finlandicus* roams freely over the leaf surfaces. Free-living eriophyids are distributed evenly over the leaf surfaces and therefore would be more susceptible to attack by *T. finlandicus* than by *T. pyri*.

Fig. 9 shows the numbers of *T. aberrans* and those of *Phytoptus avellanae* and *Tetranychus* sp. on hazel leaves in a natural woodland. In spring, the three species were approximately equal in numbers, but by July the eriophyid had

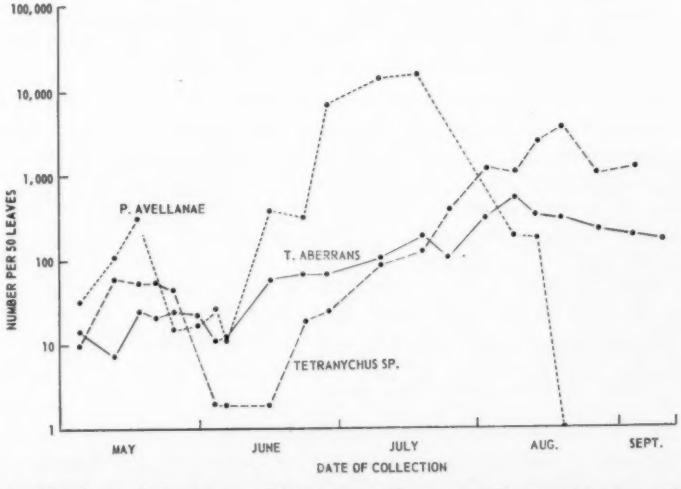


Fig. 9. Numbers of *T. aberrans*, *Phytoptus avellanae*, and *Tetranychus* sp. on hazel in a natural woodland during the summer of 1955.

reached a density of 8,000 and by August the tetranychid 3,000 per 50 leaves, and both caused moderate to severe damage. *T. aberrans* did not control these pests despite equality in numbers early in the season. *P. avellanae* left the foliage at its normal time in July and August.

Fig. 10 shows the numbers of *S. simplex* and *Phytoptus quercinus* on unsprayed oak in a woodland. Once again, the numbers of prey and predators were approximately equal in May and June, but by August the eriophyid had reached a density of 3,000 per 25 leaves and had caused slight damage. Later in August it left the foliage to overwinter. *Panonychus quercinus* (Berlese), whose numbers were not recorded, also caused damage to the leaves.

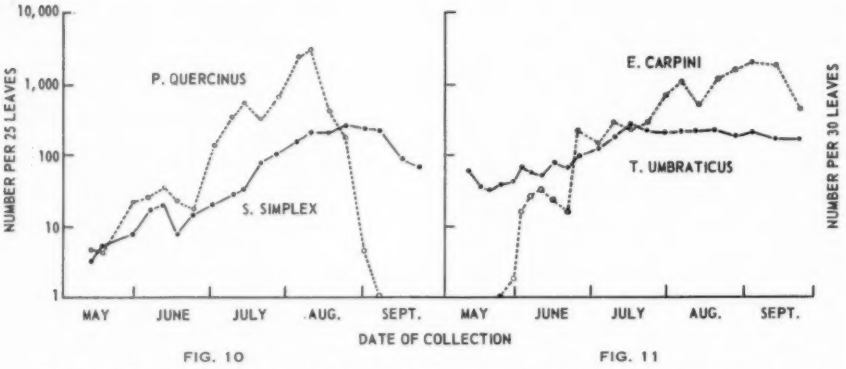


FIG. 10 FIG. 11

Fig. 10. Numbers of *Seiulus simplex* and *Phytoptus quercinus* on oak in a natural woodland during the summer of 1955.

Fig. 11. Numbers of *T. umbraticus* and *Eotetranychus carpini* on *Rubus* sp. in a natural woodland during the summer of 1955.

Fig. 11 shows the numbers of *T. umbraticus* and *Eotetranychus carpini* on unsprayed bramble in a woodland. *E. carpini* was virtually absent in the spring, and yet it increased in the presence of a large phytoseiid population to 1,300 per 30 leaves and caused severe damage. The predator seemed to check the pest slightly in the second generation, but this was only temporary.

In each of these examples, a phytoseiid failed to control other species of mites. Perhaps this was because of the great disparity between the reproductive abilities of predators and prey and because the feeding capacity of the predators was small. One cannot, of course, determine to what extent the pests would have increased in the absence of phytoseiids, but in every example cited above the pests caused damage in the presence of numerous phytoseiids, and therefore control was unsatisfactory from a commercial point of view. Nesbitt (1951) stated that phytoseiids are the most important factor controlling tetranychids under natural conditions, but the present work does not support this view. From the appearance of dead tetranychids on the leaves of the various plants investigated, I believe that insect predators were the most important mortality factor, though even these failed to prevent damage to the host plants.

Competition Between Phytoseiid Species

In addition to affecting the abundance of phytophagous species of mites, phytoseiids probably also affect the abundance of one another. Information on the interaction of phytoseiid species was obtained at Ulcombe, Kent, in 1954.

Collections of leaves were taken separately from the bottoms and tops of large, mature, unsprayed apple trees. The results (Figs. 12 and 13) suggest that *T. finlandicus* inhibited the increase of the other species present, mainly *T. pyri*, and *P. macropilis*. *T. finlandicus* and *T. pyri* appeared on the lower leaves in May (Fig. 12), increased simultaneously until June, and then the latter ceased to increase whereas *T. finlandicus* continued, to attain a density of 135 per 80 leaves. On the upper leaves (Fig. 13) *T. finlandicus* was late to appear and in its absence the other species increased normally. When *T. finlandicus* finally appeared, the others were checked and it remained dominant for the remainder of the summer. This species probably achieves success mainly by destroying the eggs and larvae of the other species, all of which oviposit on the surface of the leaf. *T. finlandicus* itself, on the other hand, is relatively free from attack because it lays its eggs on vertical leaf hairs where they cannot easily be reached. If *T. finlandicus* is encouraged to colonize commercial orchards where *T. pyri* is abundant, competition between these species may result merely in the latter being replaced rather than supplemented by the addition of the other predacious species.

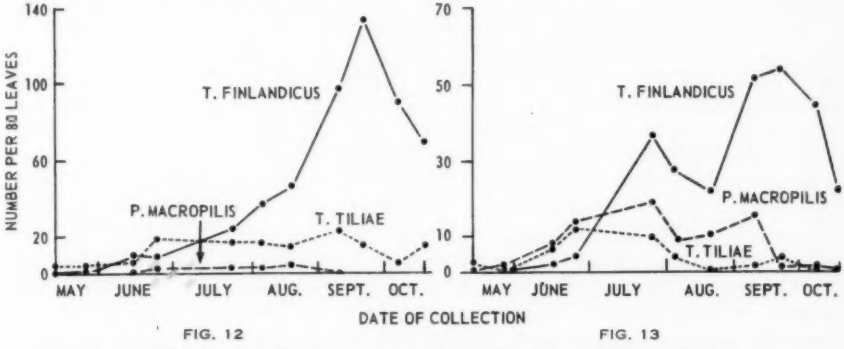


FIG. 12 FIG. 13

Fig. 12. Numbers of active stages of *T. finlandicus*, *T. pyri* (= *T. tiliae*), and *Phytoseius macropilis* on bottom halves of large, mature, unsprayed apple trees during the summer of 1954.

Fig. 13. Numbers of active stages of *T. finlandicus*, *T. pyri* (= *T. tiliae*), and *Phytoseius macropilis* on top halves of large, mature, unsprayed apple trees during the summer of 1954.

Insectary Studies

Developmental Times

The developmental times of all stages of four species of Phytoseiidae were investigated to see whether they differ. The species chosen for study were abundant, and as far as possible represented different habitats: *T. pyri* is common in some commercial orchards, *T. finlandicus* is common in unsprayed orchards, *T. bakeri* is a bark-inhabiting species, and *P. macropilis* is of general distribution and is morphologically very distinct from the others. Prior to this work, information on life-history and behaviour of phytoseiids had been obtained only for *T. cucumeris* (McGill, 1939), *T. pyri* (Herbert, 1956), and *T. fallacis* (Ballard, 1954) and these were studied under laboratory conditions and provided little information on the situation in the field.

The four species were reared in an insectary; thermograph records showed that the temperature in the shelter varied only slightly from that in the open. The cages used were of the "Huffaker" type (Peterson, 1953), modified to provide three rearing cells each, and pieces of leaves were used instead of entire

leaves. By sliding aside the microscopic cover slip over each cell, food was introduced at will, and the pieces of leaf were kept fresh for approximately one week during summer by watering around the edges of the cages. Each cell was examined daily under a dissection microscope. Approximately 40 cells, each containing one phytoseiid, could be examined in two to three hours. For feeding experiments in the absence of plant material, the cages were assembled with black instead of white blotting paper so that the mites could be seen more readily.

T. bakeri and *P. macropilis* were reared in 1954, and *T. finlandicus* and *T. pyri* in 1955. Recently matured female adults were collected in the field and maintained until they died, to determine longevity; the eggs they laid were used for rearing. *P. ulmi* was provided for food; individual mites were placed in the cells with fine brushes, and dead specimens were removed as soon as possible. Very young phytoseiids were given only larvae of *P. ulmi* but later in development all stages were provided. Phytoseiid mortality during rearing was low and its greatest cause was accidental crushing when the cover slips were moved and when the mites were transferred to fresh cages. Some died when trapped in the webbing of *P. ulmi* and approximately five per cent died while moulting or from a fungal organism tentatively identified as *Hirsutella* sp. The greatest source of loss was escape, which averaged 20 to 30 per cent. Table III shows that the species required 16 to 22 days to complete development, but the differences found cannot be used confidently for comparison between species because rearing was done in two summers and therefore not under constant conditions. The only other index available was the number of degrees of temperature required to complete development; accordingly, the day degrees(i.e., the sum of 24 hourly readings) and the day degrees above 50°, 55°, and 60° F. were calculated for each day when rearing was in progress during the two years. The total for each category was then calculated for each developmental stage of each individual that was reared. These totals were examined statistically to determine which was most suitable to show differences between species. As the four species were very different in their variation each pair of species was compared by a student's *t* test; day-degrees proved too unstable a criterion for use, but the day-degrees above 50, 55, and 60 were all useful and tended to confirm one another.

TABLE III.

Days required for development by immature stages of four species of Phytoseiidae in insectary, 1954 and 1955.

Species	Egg	Larva	Protonymph	Deutonymph	Total
T. pyri	4.2	0.9	5.7	5.5	16.2
T. finlandicus	3.9	3.4	4.3	6.1	17.8
T. bakeri	4.8	2.2	5.9	6.9	19.8
P. macropilis	5.3	1.8	7.6	6.8	21.5

The use of day-degrees as an index of development may be criticized because it ignores the probability that development is more rapid at high than at low temperatures. It assumes that the relationship between time for development and temperature is a straight line, when it is probably a curve. However, no other method was available and the highly significant differences obtained between species provide some justification for its use. The day degrees above 55° F. were selected as the developmental index in this paper; approximately 200 degrees equal 24 hours of "average" English summer weather. The totals required by each species are shown in Table IV.

TABLE IV.

Day-degrees above 55° F. required for development in insectary by the immature stages of four species of Phytoseiidae.

Species	Egg	Larva	Protonymph	Deutonymph	Total
T. pyri	946 (34)*	146 (43)	943 (26)	1071 (26)	3093 (26)
T. finlandicus	606 (41)	508 (23)	902 (20)	1467 (20)	3571 (20)
T. bakeri	667 (73)	314 (35)	1048 (18)	1193 (15)	3160 (19)
P. macropilis	780 (37)	319 (25)	1340 (17)	909 (14)	3547 (20)

*Number of specimens.

Table IV shows that the requirements for each stage differed considerably between species, and none completed development without differing significantly from at least one other species at some stage. However, the total requirements were remarkably similar despite the differences (many of which were statistically significant). There appeared to be an inverse relationship between the requirements of the egg and larval stages—*T. pyri*, *P. macropilis* and, to a lesser extent, *T. bakeri* had a long egg but a short larval stage, whereas in *T. finlandicus* these stages were similar in duration; and in *T. pyri* and *T. bakeri* the protonymphs and deutonymphs had approximately the same duration, whereas in *P. macropilis* and *T. finlandicus* the deutonymph stage was longer.

Ballard (1954) found that the males of *T. fallacis* do not pass through a deutonymph stage, and thus develop more quickly than do the females. No significant differences between the requirements of males and females were observed in the present study, and all males passed through two nymphal stages.

When a number of recently-matured females of *T. pyri* were confined with adult males the pre-oviposition period averaged four days. This, when added to the 16-day period required for development, indicates that 20 days were required by this species to complete one generation. In 1955 the peak in numbers of the first generation eggs in the field was in early June (Fig. 2), and adults of the final generation appeared in early September. Therefore, approximately 90 days were available for development and this would allow time for four generations, the number that probably occurs. Actually, the first generation evidently lasted for more than 20 days, probably because temperatures were low early in June, and this may explain why there was only a partial fourth generation.

When *T. fallacis* was reared at 78° F. and fed on *Tetranychus bimaculatus* Harvey it required only 46 hours for development of the egg, 15 for the larva, 32 for the protonymph, and 26 for the female deutonymph (Ballard, 1954). When expressed as day-degrees above 55° F., these figures agree closely with those of the present study; for example, the eggs of *T. fallacis* required 1058 day-degrees above 55° F., approximately the same as *T. pyri*. *T. cucumeris* reared at 80° F. and fed on *Thrips tabaci* Lind. sometimes required as few as 72 hours for development from hatching to oviposition (MacGill, 1939). Herbert (1956) obtained results similar to those of the present study when she reared *T. pyri* in the laboratory on *Tetranychus telarius* (L.) at both 60 and 70° F.

Parrott *et al.* (1906), Muma (1955a), and others recorded that phytoseiids prey on the minute mites of the family Eriophyidae, and several workers have suggested to me (*in litt.*) that these are the "natural" food of phytoseiids. The developmental times of *T. pyri* when fed on eriophyids were therefore investigated. Pieces of apple leaves with large numbers of the eriophyid *V. schlechtendali* were placed in Huffaker cells as described above. Table V shows that the

developmental times of both of the nymphal stages that feed were nearly halved when eriophyids were supplied in place of *P. ulmi*, and the differences were significant at the 0.1 per cent level. *T. pyri* gorges itself when fed on eriophyids but attacks *P. ulmi* only when hungry and at other times even avoids contact with it. For this reason the superiority of eriophyids as food may rest to a larger extent on a quantitative than on a qualitative basis.

TABLE V.

Developmental times of immature feeding stages of *T. pyri* when fed on two phytophagous mites in insectary*.

Food, on apple leaves	Protonymph		Deutonymph		Total	
	Day-degrees over 55°	Days	Day-degrees over 55°	Days	Day-degrees over 55°	Days
Vasates schlechtendali	601 (17)**	2.5	649 (16)	3.2	1250 (16)	5.7
Panonychus ulmi	943 (26)	5.7	1071 (26)	5.5	2014 (26)	11.2

*Differences between species significant at the 0.1 per cent level.
**Number of specimens.

FEEDING HABITS

The nature of the food of phytoseiids has attracted interest and speculation since their predacious habits were first investigated in 1906. Many workers, previously referred to, reported that these mites feed on tetranychid and eriophyid mites, and Nesbitt (1951) stated that they depend largely on tetranychids for food. Fleschner and Ricker (1954) showed that certain species of *Typhlodromus* feed on phytophagous mites on citrus, and that they prefer tetranychids to *Tydeus californicus* (Banks) or *Brevipalpus* sp. In general, relationships between phytoseiids and tetranychids have been stressed in the literature because of their economic implications, and the dependency of phytoseiids on tetranychids for food may have been exaggerated. However, the feeding habits of phytoseiids were not previously studied in detail, and the influences of various foods on their ability to develop were not determined.

Gilliatt (1935) stated that phytoseiids are partially phytophagous, but offered no supporting evidence. Mr. C. V. G. Morgan, Entomology Laboratory, Summerland, B.C., and I demonstrated the phytophagous habit of *T. rhenanus* in Western Canada in 1952 by staining plants with systemic dyes and later observing coloured intestines in mites that were allowed only the treated leaves. This was repeated in England in 1953 and 1954. Apple, blackberry, and black-currant shoots from which all mites had been removed were placed in acid-fuchsin stain. The plants absorbed the stain within 24 hours, and *T. pyri* and *T. finlandicus* subsequently placed on them were later observed to have coloured intestines. This made apparent the need for an investigation of the role of plants in the food relationships of phytoseiids. Moreover, because these mites frequently outnumber their tetranychid prey in unsprayed orchards and therefore obviously cannot rely on them for food, it was necessary to investigate alternative sources of food. Finally, because of the economic implications of the destruction of *P. ulmi*, the individual capacities of several phytoseiids for this species were determined.

Two types of cages were used for these studies. The first, the Huffaker cage described earlier, was used only when animal food was offered and was constantly added. The other was a small plastic cage developed by Mathys (1954)

for rearing *Bryobia praetiosa* Koch on living leaves. The main part of this cage is a plastic disc through which a hole is drilled. The disc is fastened to a leaf by pins that extend through minute holes in the edge of the cage, through the leaf, and into a cork disc on the other side of the leaf. The central hole, covered by a microscope cover slip, forms the rearing cell. Mathys' design was modified by increasing the width of the edge of the cage and by adding a flange to ensure a closer fit. The cage is light and needs no support, but it must be examined microscopically. As many as 50 per cent of the mites escaped or were lost during some experiments, and for this reason the number of specimens is small for some tests. Phytoseiids were placed in the cages as mature eggs or as recently-hatched larvae. Controls consisting of dry cages without food and cages in which only water was provided were used in every instance. Controlled conditions with lighting suitable for the maintenance of living plant material were not available and experiments with living plants were conducted at room temperature (60°-70° F.). Those that involved no plant food were conducted in a constant temperature of 64°. Therefore, developmental times were largely ignored between experiments, and the ability of the mites to develop or reproduce was used to evaluate the various foods. However, developmental times were considered within individual experiments.

The experiments fell into two groups: those that tested the influence of plant versus animal food in the survival and development of immature mites and that demonstrated the capacity of these mites for *P. ulmi;* and those that tested the influence of plant as opposed to animal food on the survival and oviposition of adult female mites, and that similarly demonstrated their capacity for *P. ulmi.*

Immature Mites

Influence of Food on Survival and Development

T. pyri, *T. finlandicus*, *T. umbraticus*, and *T. aberrans* were used for these experiments, the first two species because they were abundant and found on many plant species, and the last two because they were apparently restricted in distribution to a few species of host plants on which it was thought that they might have been able to develop in the absence of animal food.

Fig. 14 shows that when larvae were confined on various plants without animal food, all but those of *T. finlandicus* moulted to protonymph but none developed further. *T. pyri* lived slightly longer with water than without, and this indicated that death in the latter instance was probably caused by desiccation. There was no difference in the longevity of this species with water only and with plants only, and this suggests that plant juices are no more sustaining than water. *T. pyri* lived for a shorter time on bramble and hazel than on apple leaves or than when provided with water only, perhaps because it was difficult for the mites to obtain moisture from leaves of these types. The value of water was not tested with the other species, but each lived longer with plant material than without food or water.

When apple powdery mildew, *Podosphaera leucotricha* (Ell. & Everh.), developed in cages where *T. pyri* was being reared, the mites moulted to deutonymphs and then completed development. Later, when cages were deliberately established on mildewed leaves, both sexes of this species invariably completed development and lived for a number of days in the adult form; one female lived for 69 days. In a few instances larvae of *T. umbraticus* and of *T. aberrans* were placed on mildewed leaves, and completed their development to adults. It was not possible to compare developmental times between mites reared on mildew and on animal food because they were reared under different conditions.

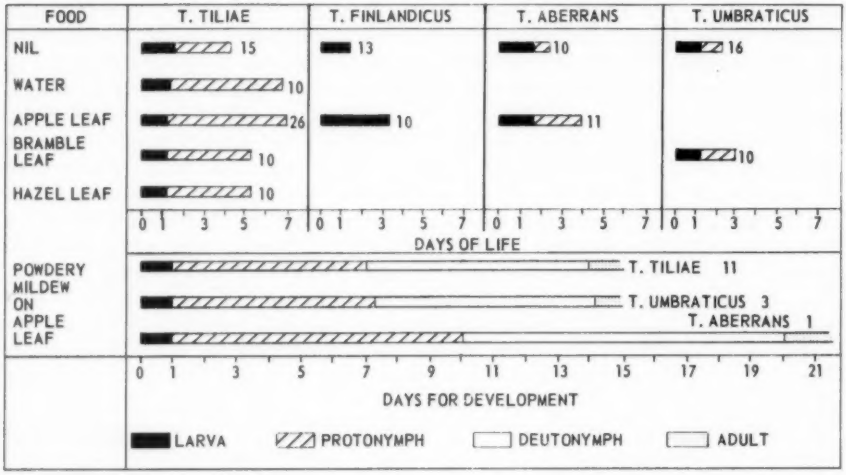


Fig. 14. Development of four species of Phytoseiidae on various foods in the laboratory. (The number of specimens is given with each bar). (*T. tiliae* = *T. pyri*).

To determine the number of *P. ulmi* required by *T. pyri* for development in the absence of plant food or water, an experiment was conducted at a constant temperature of 64° F. To maintain uniformity only larvae of *P. ulmi* were provided as food; larvae were chosen because young *T. pyri* protonymphs cannot feed on the larger stages. Two to 12 *P. ulmi* larvae were supplied at the rate of one each day, and the longevities of the immature predators were observed for each total. It was intended to increase the number of prey by intervals of two until a group of the predators had completed development, but rearing was unexpectedly time-consuming and it was impractical to do this beyond the deutonymph stage. A final group was provided with larvae of *P. ulmi* until development was completed to determine the total number of prey necessary for development.

Table VI shows that the nymphs lived for 5.2 days (from hatching) at 64° without food or water, and this was one day longer than at room temperature. They lived for slightly longer with water only, and with two *P. ulmi* larvae and no water, and approximately one day more for each additional larva eaten until the deutonymph stage was attained. An average of 25 *P. ulmi* larvae (range 19-31) was necessary for development to adulthood in the absence of water.

An attempt was made to determine the number of larvae necessary for development when water was available. The only results that were obtained from this also appear in Table VI; only six instead of eight prey were needed for protonymphal development when water was present. The experiment could not be continued to determine the total number needed for development because the nymphs of *T. pyri* eventually drowned in condensed moisture on the covers of the cages.

A small test to determine whether the rate at which prey were supplied had any effect on the developmental time of *T. pyri* suggested that the rate of development increased when prey were supplied in larger quantities but the total number of prey required probably remained approximately constant. Temperature, of course, must also affect development, and in the field the nymphs of *T. pyri*

probably feed on stages of *P. ulmi* that are larger than the larval stage, and the number of prey required may be reduced in this way.

TABLE VI.
Development of *T. pyri* when fed on various numbers of larvae of *P. ulmi* in absence of plant material and water, and with apple leaves.

Food	Days of life or developmental time (from hatching)	Percentage attaining protonymph stage	Percentage attaining deutonymph stage	Percentage attaining adult stage	Number of specimens
Nil	5.2	100	0	0	15
Water only	5.8	100	0	0	10
2 larvae, no water	6.7	100	0	0	14
4 larvae, no water	9.4	100	0	0	12
6 larvae, no water	12.0	100	0	0	14
8 larvae, no water	14.0	100	10	0	9
10 larvae, no water	16.0	100	70	0	9
12 larvae, no water	18.0	100	100	0	1
25 larvae, no water	26.0	100	100	100	13
6 larvae, with water	14.8	100	20	0	5
Apple leaf only	6.5	100	0	0	26
1 larva, with leaf	8.0	100	0	0	10
2 larvae, with leaf	9.5	100	0	0	8
3 larvae, with leaf	15.0	100	100	100	12
Powdery mildew, with leaf	12.8	100	100	100	11

Finally, the influence of plant feeding on the number of prey required by *T. pyri* for development was investigated; the large number of prey found necessary in the absence of plant material was thought to be artificial in that the primary purpose of feeding might be to obtain water from the bodies of *P. ulmi*. Recently hatched predator larvae were confined on leaves with various numbers of *P. ulmi* larvae, and their longevity at each prey density was observed. Table VI shows that on apple leaves when one or two prey larvae were eaten the mites died when protonymphs but the predator completed development when three or more larvae were eaten. Development was slower than with powdery mildew but perhaps it would have been more rapid if more prey had been supplied.

In summary, the species of Phytoseiidae examined could not complete their development on leaves alone, but apple powdery mildew provided sufficient food for development to be completed. *T. pyri* required 25 *P. ulmi* larvae to complete development at 64° F. in the absence of plant material or water, but only three larvae when confined on living apple leaves. Longevity with water only was approximately the same as with apple leaves, but apparently the presence of moisture did not greatly reduce the number of prey required at 64° F. in the absence of plant material.

Capacities for *Panonychus ulmi* and *Vasates schlechtendali*

Table VII shows that in the insectary with an abundance of prey and plant food *T. pyri* and *T. finlandicus* generally ate more of *P. ulmi* than did *T. bakeri* or *P. macropilis*. In two instances sexual differences in capacity were evident: male deutonymphs of *P. macropilis* ate fewer than did females, and the total eaten by male *T. finlandicus* nymphs was less than that of females though differences between individual stages were not significant. The relative capacities of protonymphs and deutonymphs in each species depended largely on their developmental times. *T. finlandicus* larvae are unique among phytoseiids in that they

are predacious; they ate an average of 6.8 *P. ulmi* larvae during development. For this reason, the total capacity of the nymphs of this species is greater than that of the others. The larvae of the other species do not feed and are inactive when disturbed, whereas larvae of *T. finlandicus* roam over the leaves. Unlike the larvae of other species, those of *T. finlandicus* did not moult when they were confined on apple leaves without other food materials.

TABLE VII.

Mean numbers of *P. ulmi* eaten by the immature stages of four phytoseiids in insectary.

Species	Larva	Protonymph	Deutonymph	Total	Per Day of development
T. pyri	0	10.2	7.6	17.8	1.4
T. finlandicus	6.8	8.4	9.8	27.0	1.9
T. bakeri	0	4.7	5.7	10.2	0.6
P. macropilis	0	7.5	6.9	14.4	0.9

The average number eaten by *T. pyri* nymphs (17.8) was more than the minimum necessary for development on apple leaves (three) but less than the number required for development in the absence of apple leaves (25 at 64° F.). However, they might well eat fewer under completely natural conditions because the cut leaves used in the insectary were probably less nutritious than living leaves and the nymphs might therefore have been forced to eat a larger number of *P. ulmi* to satisfy their needs.

For comparison with the above data, Table VIII shows the numbers of *V. schlechtendali* eaten by *T. pyri* nymphs on cut apple leaves in an insectary. *V. schlechtendali* is much smaller than *P. ulmi*, of course, and this may be why more of this species than of *P. ulmi* were eaten by *T. pyri* immatures during development.

TABLE VIII.

Mean numbers of *Vasates schlechtendali* eaten by *T. pyri* in immature stages in insectary.

Stage	Per day	During development	Number of specimens
Larva	0	0	18
Protonymph	32.0	80.2	18
Deutonymph	16.9	54.3	16
Total	23 2	132.8	16

Adult Mites

Influence of Food on Survival and Oviposition

T. pyri was studied the most intensively, but some data on the influence of food were also obtained for *T. bakeri*, *T. finlandicus*, and *P. macropilis*.

The influence of food on the longevity and fecundity of recently matured, adult females of *T. pyri* is shown in Table IX. Life was short without food or water, but was progressively longer with water, apple leaves, apple powdery mildew on leaves, and *P. ulmi* on leaves. Longevity on apple leaves was more than twice that with water only, indicating that the plant juices furnished material of food value in addition to moisture. Longevity on *P. ulmi* alone was not tested.

TABLE IX.

Influence of food on the longevity and fecundity of adult females of *T. pyri*.

Foods provided	Days of life	Eggs laid per 10 females per day
Nil	2.5	0
Water	7.5	0
Apple leaf	16.6	0
Powdery mildew	21.0	0.5
Apple pollen	—	1.3
P. ulmi on apple leaf	29.6	3.1

Usually each female laid an egg in the first or second day of captivity, regardless of food supply, and in these experiments only the second and subsequent eggs were considered. The experiments were continued until the female died, except when pollen, which was available for only a few days, was used. No eggs were laid when the females were without food or water, with water only, or with apple leaves only. A few eggs were laid when the females were provided with fungal spores or with apple pollen, and when *P. ulmi* and apple leaves were provided each female laid an average of three eggs every 10 days.

Table X shows that *T. bakeri* and *P. macropilis* lived for a shorter time than *T. finlandicus* on *P. ulmi* and apple leaves. The withholding of *P. ulmi* affected *T. finlandicus* severely in that it shortened its life by approximately 80 per cent, whereas *T. pyri* showed a comparable reduction of less than 50 per cent.

TABLE X.

Fecundities and longevities of the adult females of four species of Phytoseiidae, and the mean numbers of *P. ulmi* in all active stages eaten per day by the adult females of these species.

Food provided	Species	Mean days per egg	Mean number of *P. ulmi* eaten per day	Mean days of life
Panonychus ulmi on apple leaves.	*T. pyri*	3.1 (10)*	2.9 (10)	29.6 (10)
	T. finlandicus	5.0 (11)	2.3 (11)	37.5 (11)
	T. bakeri	8.7 (23)	1.1 (23)	26.9 (23)
	P. macropilis	12.0 (14)	1.1 (14)	24.5 (14)
Apple leaves only	*T. finlandicus*	10.2 (10)	—	7.3 (10)
	T. pyri	0 (10)	—	16.6 (10)

*Numbers of specimens.

Table X also shows that *T. pyri* and *T. finlandicus* laid two to three eggs per female every 10 days, but the fecundity of the other species was much less. With only apple leaves for food *T. pyri* laid no eggs, whereas *T. finlandicus* laid an average of almost one egg every 10 days.

Herbert (1956) investigated both the longevity and fecundity of *T. pyri* reared at 60 and 70° F. in gelatin capsules and fed on an abundance of the eggs of *Tetranychus bimaculatus* Harvey. She found that longevity was greater at the lower temperature and that increasing the food supply caused the number of eggs laid to increase. She reported much greater longevities of *T. pyri* than were found in the present study but some of her results indicate that *T. bimaculatus* eggs as food prolong life to a greater extent than do the active stages of *P. ulmi*.

In conclusion, *T. umbraticus* was found to develop on blackberry leaves in the field in the absence of other mite species when spores of the raspberry leaf-rust (*Phragmidium rubi-idaei* (Pers.)) were abundant. The mites were frequently seen to eat spores, and spore eruptions were sometimes destroyed completely. This species was also seen to feed on pollen in the blossoms of *Rubus* spp. and in fallen hazel catkins. *T. aberrans* frequently feeds on hazel pollen, and other phytoseiids feed on willow catkins in spring. Females of *T. pyri* were observed in apple blossoms many times, and feeding on pollen grains that had fallen onto leaves.

Capacities for *Panonychus ulmi* and *Vasates schlechtendali*

Table X shows that when a surplus of prey was always present, *T. pyri* and *T. finlandicus*, the species with the greatest longevity, tended to consume more prey than *T. bakeri* or *P. macropilis*.

Gilliatt (1935) recorded a capacity of 1.9 of *P. ulmi* per day for "*Seius*" sp. in Eastern Canada and the present results confirm this data. Listo *et al.* (1939), however, claimed that "*Seiulus*" sp. destroyed an average of 312 of *P. ulmi* per day (13 per hour) in Finland. Their observations were indirect and were based on a reduction of *P. ulmi* on individual apple spurs in a given time in the field. Probably this reduction was caused by dispersal (Marle, 1951) or by some factor not considered, or perhaps their predator was not a phytoseiid but was of another family of Acarina. Ballard (1954) and Herbert (1953) reported that *T. fallacis* and *T. pyri* ate large numbers of the eggs of *Tertanychus telarius* (L.) in the laboratory, but one cannot equate their figures to those for the active stages of *P. ulmi*.

The eggs of *P. ulmi* are less delicate than those of many other tetranychids and whether phytoseiids feed on them is contentious; no experimental evidence has been advanced in support of either view. Newcomer and Yothers (1929) believed *Seius* sp. to be an egg predator, whereas Kuenen (1947) said that it was not; possibly different species were involved. Collyer (1953a) stated that *T. pyri* feeds on winter eggs of *P. ulmi* in England, and Collyer and Kirby (1955) and Collyer (1957a) stated that this species also feeds on the summer eggs of *P. ulmi*. In an earlier section it was shown that the abundant species of *Typhlodromus* in southeastern England, including *T. pyri*, could not be induced to feed on winter eggs during the present investigation. In summer, 10 females of *T. pyri* were confined with only the summer eggs of *P. ulmi* for food. *T. pyri* died of starvation when no eggs hatched within a week; the mites appeared to be incapable of piercing the shells of undamaged eggs. However, when the eggs ruptured prior to hatching, the predators readily fed on the mature larvae inside, and in this way gave the appearance of feeding on the eggs themselves.

Five *T. pyri* females consumed an average of 27.9 of *V. schlechtendali* each per day for 10 days. One female ate 92 in 12 hours. When offered a choice of this eriophyid and *P. ulmi*, no discrimination was exercised if *T. pyri* was starved. However, partially fed *T. pyri* refused to feed on *P. ulmi* but continued to eat *V. schlechtendali* until gorged.

In addition to these two prey species, *T. pyri* was observed feeding on the following species of mites: *B. praetiosa* (larvae), *Tetranychus telarius* L., *Eotetranychus carpini*, *Panonychus quercinus*, *Vasates fockeui* (Nal. and Trov.), *Phytoptus avellanae*, *P. quercinus*, *P. gracilis* Nal., *Tydeus* spp., *Eupalopsis* sp., *Brevipalpus geisenheyneri* (Rübsaamen), *Neophyllobius* sp. (larvae), *Moniziella corticalis* Michael, *Tarsonemus* sp. (eggs), and other phytoseiids.

INFLUENCE OF FEEDING HABITS ON EFFECTIVENESS OF *T. pyri* AS A PREDATOR OF *Panonychus ulmi* (KOCH)

The results of the foregoing experiments illustrate several points regarding *T. pyri*, and to a lesser extent the other species investigated, that might have a bearing on their efficiencies as predators of *P. ulmi* in orchards. The variety of food found to be acceptable to them made it necessary to assess the role that these foods play under field conditions when an abundance of prey is present.

A major difficulty in the study of predator-prey relationships is the determination of when a predator has fed on a prey. This is relatively easy with phytoseiids because the contents of the H-shaped intestine can be seen through the transparent body wall, and when *P. ulmi* was the food the intestines became bright red or green, later fading to brown. Brightly-coloured female mites were collected in orchards in 1954 and 1955 and kept until the colour disappeared to determine its duration. Colouration was induced in others by feeding on *P. ulmi* and its duration recorded, both when indoors and out; in all, a total of 30 females were studied. All of these retained their colour for two days, and 84 per cent for three days (nymphs and males retained their colour for similar lengths of time). Therefore, colourless mites in orchards may be considered not to have fed on *P. ulmi* for at least two days, and probably three.

In 1953 many colourless specimens of *T. pyri* were collected in orchards where *P. ulmi* was abundant. In 1954 records from three orchards where *P. ulmi* was plentiful showed that usually not more than 40 to 50 per cent of the predators were coloured. In 1955 weekly collections of 50 leaves each were taken from five Lane's Prince Albert apple trees that were heavily infested with *P. ulmi*. Fig. 15 shows the numbers of *T. pyri* and *P. ulmi* on these during the season (the vertical scale is logarithmic) with the percentages of the total active stages of *T. pyri* (excluding larvae, which do not feed) that showed coloured intestines. The greatest percentage with coloured intestines recorded during the summer was 63, and less than fifty was the more usual. Thus, in general, less than half of the *T. pyri* present at any one time had recently fed on *P. ulmi*, and there was no indication that the incidence of feeding reflected prey density. Of

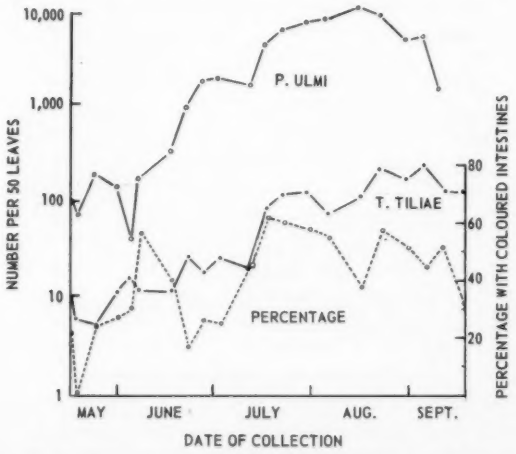


Fig. 15. Numbers of all stages of *T. pyri* (= *T. tiliae*) and *Panonychus ulmi* in P10 Orchard during the summer of 1955 and the percentages of the active stages (except larvae, which do not feed) of the predator observed with intestinal coloration.

course, a larger number of *P. ulmi* were eaten as the summer progressed because the number of *T. pyri* increased. *P. ulmi* had five generations and increased to a density of 220 per leaf, whereas *T. pyri* had four generations and increased to 4.6 per leaf. However, a smaller percentage of *P. ulmi* must have been destroyed, for *P. ulmi* increased in number more rapidly than did *T. pyri* and the percentage of recently-fed predators did not increase as the season progressed.

No such absence of feeding on *P. ulmi* was observed in the insectary, probably because the variety of alternative food that was present in the field was not available there. On apple trees *T. pyri* had no need to rely upon *P. ulmi* for food because they were also able to feed on mildew, pollen, and the leaves themselves.

Fig. 16 shows that in general the adult female predators fed on *P. ulmi* the most frequently and the adult males the least frequently. There was a slight correlation between increases in the numbers of males and nymphs and the percentages that had fed recently and this may indicate that younger individuals fed the most frequently.

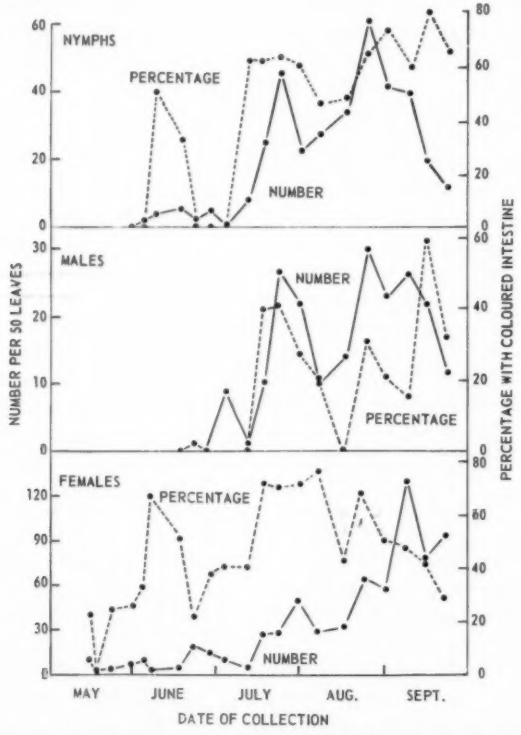


Fig. 16. Numbers of various stages of *T. pyri* that showed feeding on *P. ulmi* in P10 Orchard during the summer of 1955.

DISCUSSION ON FEEDING HABITS

Several conclusions may be drawn from the series of experiments described above. Phytoseiids feed readily on leaf juices, and the mites that feed on the juices live longer than when they are starved. However, foods with greater nutritive value promote greater longevity and are needed both by nymphs for development and, with the possible exception of *T. finlandicus*, by adult females

for oviposition. Food of this kind is provided not only by other mites but also by such plant materials as fungal spores and pollen grains. The number of animal prey necessary for nymphal development is small when plant juices are available, and in all species studied the capacity for *P. ulmi* is small at all times. Finally, with *T. pyri*, sources of food other than *P. ulmi* can be utilized in the field, and the incidence of feeding by this species apparently does not increase with increasing prey density.

Distributions of Predators and Prey in Apple Trees

The distribution of an organism within its environment is an important aspect of population character. The distribution of a predacious organism in relation to that of its prey may influence its effect on the prey, and to exert its maximum effect a polyphagous predator should be present and active in all places inhabited by the prey. Such a predator may not be able to permanently control a pest if there are areas where the pest is free from attack, because continual reinfestation will occur from these areas to the detriment of any balance the predator may have been able to achieve elsewhere.

The macroenvironment of phytoseiids inhabiting orchards is the fruit tree, and each is composed of a number of shoots and spurs, each with a number of leaves. Therefore, individual leaves are the ultimate habitats of these mites and their distributions on these should be studied. Their distributions on the spurs and shoots, which are units of several leaves, should also be studied. Their distributions in these places should reflect environmental influences but this does not necessarily apply to their distributions within the tree itself because other factors may exercise disturbing influences. For example, overwintering sites occur mostly on the older, rougher branches of trees, and overwintered mites probably colonize the leaves nearest to these sites. The distributions within trees early in the year may, therefore, merely reflect the location of suitable overwintering sites.

In addition to information on spatial distribution within habitats, numerical variations between habitats should be investigated as this may also reflect population characteristics. The distributions of *T. pyri* and *P. ulmi* on leaves, between leaves, and within spurs and shoots were investigated to gain a more thorough understanding of the effectiveness and limitations of the predator.

Distribution on the surfaces of apple leaves

Collections of leaves were taken regularly from two unsprayed orchards, in one of which *T. pyri* was abundant and in the other *T. finlandicus*, and from a sprayed orchard where *P. ulmi* was abundant. For studies on distribution, leaves were taken from the samples as soon as possible after collection and the locations of the mites on the lower surface of each were plotted on a stylized plan. The composite plans that were obtained are shown in Fig. 17. *T. finlandicus* was uniformly distributed over the lower surface and showed no preference for any part of the leaf. On the other hand, *T. pyri* was found normally along the central rib and large subsidiary veins. A possible explanation of this distribution is that it is an adaptation acquired to avoid macropredators: *T. pyri* is slow-moving until disturbed, whereas *T. finlandicus* moves rapidly over the leaf even when undisturbed. Both are attacked by predacious insects and possibly *T. finlandicus* evolved a method of escape that depends on speed, thus enabling it to move freely over exposed surfaces, whereas *T. pyri* depends on concealment. *P. ulmi*, like *T. finlandicus*, was uniformly distributed. Concentrations of *P. ulmi* may occur along the midrib early in summer, but in general its distribution was uniform.

Similar distributions were observed on apple varieties other than the Lane's Prince Albert, with which this experiment was conducted.

Because of their distribution patterns on individual leaves, a large portion of the *P. ulmi* population is relatively free from attack by *T. pyri*, the most abundant predacious mite in commercial orchards in southeastern England. The adults of *P. ulmi* probably wander over the leaf and those that cross the midrib are vulnerable to attack, but the adults that are not destroyed in this manner are free to lay eggs with impunity on much of the leaf surface. *T. finlandicus* is rarely found under commercial conditions, but it is potentially a more effective predator than *T. pyri* because its distribution is similar to that of *P. ulmi*. Consequently its presence in orchards should be promoted.

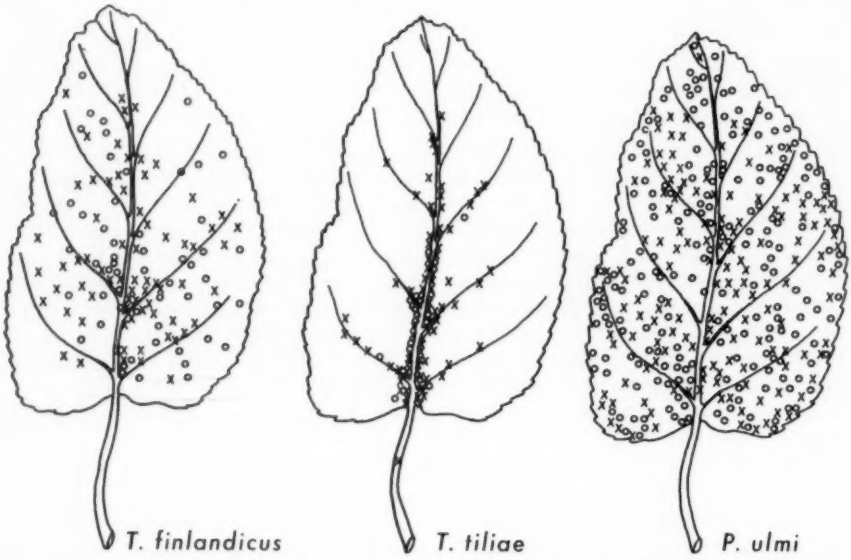


Fig. 17. Distributions of eggs (x) and adults (o) of two phytoseiids and *P. ulmi* on lower surfaces of apple leaves. (*T. tiliae* = *T. pyri*).

Fig. 17 concerns only the lower surfaces of apple leaves. Phytoseiids are rarely found on the upper surfaces in the field, though 15 to 30 per cent of the total population of *P. ulmi*, even at low densities, is on the upper surfaces (Blair and Groves, 1952). This portion is free from attack by both *T. pyri* and *T. finlandicus* and therefore perhaps neither can be adequate as a control agent. This distributional characteristic may also play an important role in glasshouse experiments on the effects of these predators that are occasionally attempted with seedling plants. Phytoseiids occur on all parts of the leaves on apple seedlings, probably because of the peculiar physical character of seedling leaves, and this may account for the success of such experiments in the face of contradictory field evidence.

Interleaf distribution

In 1955 collections of leaves were taken frequently from an unsprayed orchard, to follow the development of *T. pyri* as described above. To investigate the interleaf distribution of this mite, records were taken of the numbers of mites on individual leaves as well as of the total numbers from May to mid-September.

These records were divided into those taken in early summer (May-June), midsummer (late June, July, early August), and late summer (late August, early September).

Negative binomial distributions were fitted to these three population curves of *T. pyri*. The three distributions had the parameters m and k equal to 0.867 and 0.269, 3.826 and 0.849, and 5.726 and 4.682 respectively. The first of these parameters is the mean and the second the exponent, which is a measure of dispersion. The change in k as well as in m indicates increased dispersion during the season as well as an increase in total numbers. The fit of the distribution was excellent in early summer, fair in midsummer, and poor in late summer and early autumn. In the last case, more high numbers were observed than one would expect from the negative binomial distribution; because the only other biologically probable distribution has a less-pronounced "tail" than the negative binomial, it was not fitted. Thus, the negative binomial appeared to give the best fit throughout. When least satisfactory, presumably there were disturbances that influenced the population other than those accounted for simply by movement of the mites, such as leaf senescence, predation, or a number of other factors that were not investigated.

Fig. 18 indicates that most of the population of *T. pyri* was concentrated on a few leaves in early and midsummer. These were probably colonized by overwintered females that produced progeny that did not disperse until late summer and early autumn. For much of the year there were many leaves on which no, or only very few, predators were present. This investigation was conducted at a site where the number of *T. pyri* was greater than that usually found in commercial orchards.

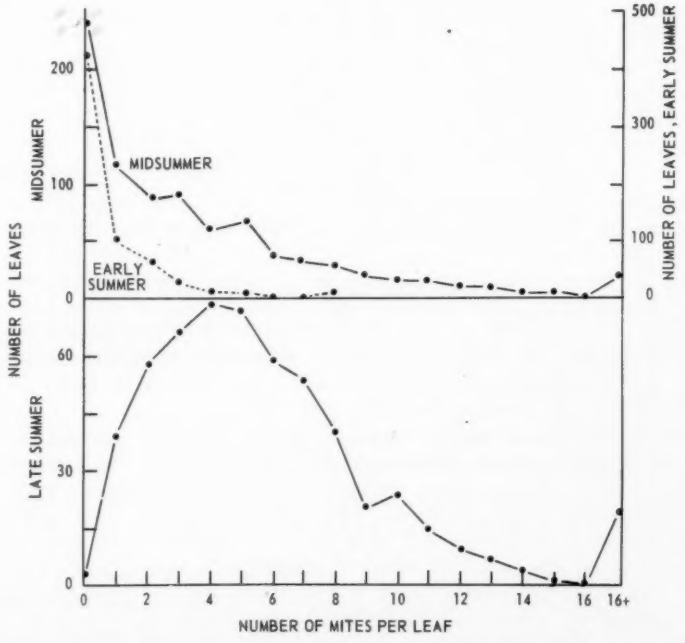


Fig. 18. Interleaf distribution of *T. pyri* in unsprayed apple orchard during the summer of 1955.

In 1954 and 1955 large collections of leaves were taken from a lightly-sprayed orchard where few phytoseiids were present. During an ecological study conducted by the Entomology Section at East Malling, these leaves were sampled by the imprint method to estimate population densities of *P. ulmi* (Venables and Dennys, 1941; Austin and Massee, 1947; Chant and Muir, 1955; Morgan *et al.*, 1955). This provided a permanent record from which information on variation could later be extracted of the numbers of mites on individual leaves. This was done only in spring and early summer because later in the year nearly every leaf had a population of *P. ulmi*.

A negative binomial distribution was fitted to the numbers of *P. ulmi* for May-June. The parameters of the distribution were $m = 20.395$ and $k = 0.578$, and the distribution did not give a good fit. Inspection of the data suggested that there were fewer leaves with no mites and more with small numbers than would be expected on the negative binomial hypothesis; this in turn suggested an even dispersion of *P. ulmi* among the leaves with, however, some large clusters. Whatever the cause, the distribution was quite unlike any observed for *T. pyri* (Fig. 19), and it seems improbable that a predator distributed as was *T. pyri* could be fully effective against a prey distributed as was *P. ulmi*.

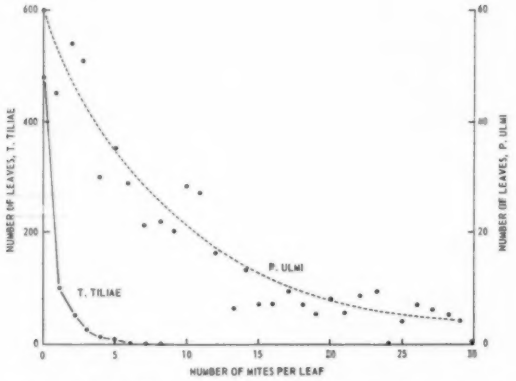


Fig. 19. The interleaf distributions of *T. pyri* and *P. ulmi* in the early summer of 1955.

Distribution on shoots and spurs

Shoots (i.e., growing tips) and spurs were considered to be similar ecological units for this study. In 1954 *T. pyri* and *P. ulmi* each had similar distributions on the two types of growth, though the predator was less numerous on shoots than on spurs, and in 1955 only spurs were considered.

Samples of 10 to 20 spurs, depending on the abundance of mites, were cut from trees at frequent intervals from May to September in 1954 and 1955. Two orchards of Lane's Prince Albert variety were used: an unsprayed one where *T. pyri* was abundant and a sprayed one where *P. ulmi* was abundant, and there was no possibility that the distribution of either the predator or the prey could have been modified by the other. It was impossible to demonstrate the effect of the predator on the distribution of *P. ulmi* because commercial orchards where both were abundant were not available for this purpose.

Each leaf was cut from the spurs and the mites on it recorded. All collections did not show equally clearly defined distributions but invariably the trends

shown in Fig. 20 were evident and there was only slight variation in character between samples. *T. pyri* was most abundant on the younger leaves near the tips of the spurs throughout the summer. There was an average of 10 leaves on each spur in early summer, and most predators were found on leaves four to 10 (i.e., leaf one being the oldest), and leaf number six was the most frequently inhabited. Later, after the senescent basal leaves had fallen in June (i.e., "June drop"), an average of only seven leaves were on the spurs. *T. pyri* continued to move to the most recently developed leaves, and in late summer most of the population was on leaves six to 10 with the highest frequency on leaf eight or nine.

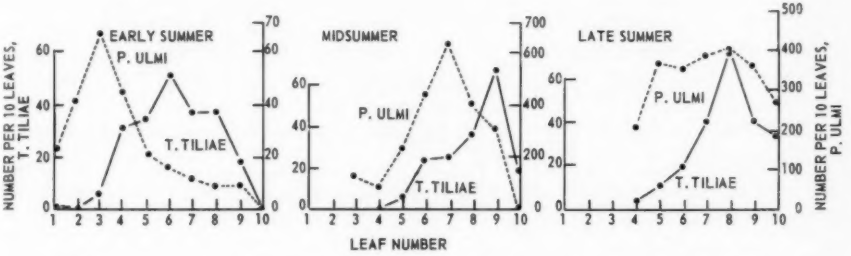


Fig. 20. Numbers of *T. pyri* (= *T. tiliae*) and *P. ulmi* on various leaves of apple fruit spurs at three times during the summer. (Leaf 10 is the youngest).

The distribution of *P. ulmi* was somewhat different; in early summer this species was most abundant on the older leaves of the spurs. Basal leaves are the first food encountered by the young larvae as they move up the twigs from their hatching sites in the spring, and these leaves are probably colonized for this reason. Subsequently, *P. ulmi* moved progressively up the spurs as the basal leaves passed maturity and fell from the trees until, by midsummer, it occupied approximately the same position as *T. pyri*, though it was somewhat more widely dispersed. *P. ulmi* was distributed uniformly over the spurs in late summer, though the largest leaves generally had the largest colonies.

These data suggest that there is an essential difference between the patterns of distribution of *T. pyri* and *P. ulmi*. In early summer, when the numbers of *P. ulmi* were smallest and the predator had the best opportunity to effect control (Collyer and Kirby, 1955), most of the predators were located where the prey was least abundant: most of *P. ulmi* were on leaves without *T. pyri* and therefore could increase almost unchecked. This distribution was stable, and existed at night as well as during the day. Not until midsummer, when *P. ulmi* had greatly increased in density, did the two populations intermingle, and perhaps at this time *T. pyri* really exerted its greatest influence. In late summer, when *P. ulmi* was uniformly distributed, much of the population again was free from predation because its distribution extended beyond that of the predator.

An isolated observation from an orchard where both *T. pyri* and *P. ulmi* were abundant showed that in early summer the distribution of *T. pyri* that had recently fed on *P. ulmi* was the opposite of that for all of *T. pyri*. Fig. 21 shows that the percentage of *T. pyri* with coloured intestines was greater on the basal leaves, where *P. ulmi* was plentiful, than on younger leaves, where the majority of the predator population occurred but where *P. ulmi* was scarce. The predator population must have been very stable to have maintained such a gradient.

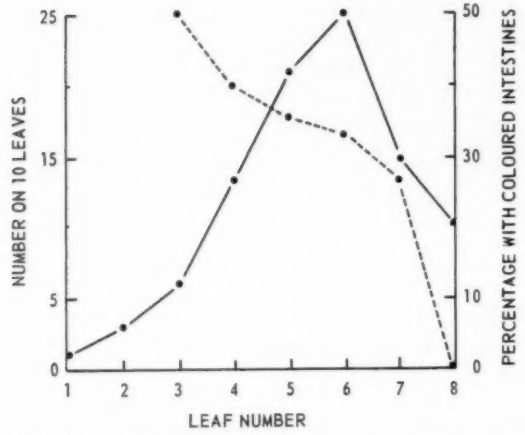


Fig. 21. Numbers (solid line) of *T. pyri* and percentages (broken line) with intestinal coloration on the various leaves of fruit spurs in the early summer of 1955. *P. ulmi* was most abundant on the older leaves (i.e., leaf 1 was the oldest).

Field observations suggested that *T. finlandicus* was more nearly uniformly distributed among leaves than *T. pyri* but this could not be verified because the nearest source of this species was so far from the laboratory that a mingling of mites from leaf to leaf occurred in transportation.

Apparently, then, all aspects of the distribution of *T. pyri* differ from those of *P. ulmi*. Much of the leaf surface is free from the predator whereas *P. ulmi* has a uniform distribution. The variation in distribution among leaves indicates that *T. pyri* does not colonize all leaves until late summer, whereas *P. ulmi* is found on the majority from early summer onwards; and that *T. pyri* prefers the younger leaves on spurs and shoots throughout the summer, whereas *P. ulmi* is most numerous on rosette leaves in spring and early summer, and in late summer has a uniform distribution that overlaps that of the predator. Therefore, during much of the season *P. ulmi* is probably able to increase almost free from the controlling influence of *T. pyri*.

Effectiveness of *T. pyri* as a predator of *P. ulmi*

The practical objective of the work described above was to gather information on the lives and activities of phytoseiid mites on fruit trees that might enable these mites to be used more effectively for the control of *P. ulmi*. *T. pyri* is the only species that occurs abundantly in commercial orchards in England and, therefore, at present it is to this species alone that we must look for any contribution in this regard. If *T. pyri* is to be conserved in orchards, it must first be shown to be an efficient and effective predator.

Two requirements are necessary to demonstrate the effectiveness of any predator: an inverse numerical relationship must be demonstrated between prey and predator in time or space; and it must be proved that the predator is capable of limiting the abundance of the prey. It has been the practice in orchard experimentation to apply various chemicals to test their effects against beneficial and harmful species of insects and mites. When inverse numerical relationships between predators and prey are obtained from this, the first requirement is fulfilled. This has been done frequently with *P. ulmi* and its predators, including

phytoseiids (Gilliatt, 1935; Garman, 1937, 1938; Houser and Cutright, 1941; Cutright, 1942, 1944; Lord, 1949; Clancy and Pollard, 1952; Herbert, 1953; Collyer, 1953a; Collyer and Kirby, 1955; Muma, 1955a; and others), but never has the second requirement been fulfilled and the value of these predators conclusively demonstrated. Therefore, there is an abundance of circumstantial evidence on the value of phytoseiids in the control of tetranychids, but factual evidence is almost entirely lacking.

The dangers in accepting circumstantial evidence from the use of chemicals to obtain differential populations of predators have been pointed out by DeBach (1946), who showed that subtle side-effects that may follow the use of chemicals may render results misleading. To obviate physical side-effects, such as the removal of mites and insects by washing, DeBach recommended the use of water-sprayed controls in all experiments of this type. I consider that even this precaution is not sufficient with experiments on *P. ulmi* and its predators; some workers have observed infestations of tetranychids to be aggravated by dusts and other inert materials on leaves (Holloway *et al.*, 1942; Fleschner and Ricker, 1953), and Hueck *et al.* (1952) suggested that DDT acts as a physiological stimulant to fecundity in *P. ulmi*. Moreover, various workers have reported that substances that increase the vigour of the host plant may cause insect and mite pests to increase (Creighton, 1938; Kuenen, 1949; Rodriguez, 1951). In view of this, it seems unwise to induce differential predator densities by the application of sprays when the less-obvious effects such as these may be of such importance.

Smith and DeBach (1942) suggested, as an alternative, excluding predators from experimental trees or plants by physical means. Huffaker and Kennet (1953) removed *T. reticulatus* Oudms. by hand from strawberry plants on a small scale, and demonstrated that this species can control *Tarsonemus pallidus* Banks in California. However, this cannot be done on a large scale in orchards and an alternative method for removing phytoseiids must be used. As shown above, phytoseiids may overwinter in bands of sacking placed around the trunks of young, smooth-barked trees. If these bands are removed in winter, differential densities of these mites result the following summer.

An orchard of 192 seven-year-old Lane's Prince Albert apple trees on Malling VII rootstock was available at East Malling in 1954 and 1955 for studies on the effect of *T. pyri* on *P. ulmi*, both of which were abundant. These trees were tied to stakes for support and there were bands of sacking on the trunks to protect them from chafing against the stakes. The orchard was divided into twelve 16-tree plots (four trees square) and three treatments were each replicated four times. In the winter of 1953-54, these treatments consisted of removing the bands from plot I, leaving them untouched on plot II, and protecting the bands with waterproof fabric on plot III. All trees then were sprayed with a three per cent wash of DNOC/petroleum (March 22), and fresh bands were put on plot I to replace those that had been removed. No differences in the abundance of *T. pyri* were observed between plots II and III the following summer, and unprotected bands were therefore considered to shelter overwintering specimens of *T. pyri* from this spray completely. The winter wash killed some *P. ulmi* winter eggs on all plots but, despite this mortality, high pest densities developed. In the winter of 1954-55 the bands on plot I were again removed and those on plots II and III were left untouched, and the same winter wash was uniformly applied (March 16). In this year the discarded bands from plot I were placed on the trees of plot III to produce an artificially high density of predators the following summer so that a more significant effect on *P. ulmi* might result.

In the summer of 1954 four, and in that of 1955 five, collections of leaves were taken from this orchard. Each collection consisted of 10 leaves from each of four trees in the centre of each replicate (i.e., 40 leaves per replicate and 160 leaves per treatment). With the mite brushing machine, the numbers of *T. pyri* and *P. ulmi* were recorded (Fig. 22). In 1954 moderate success in obtaining differential densities of *T. pyri* was achieved, for there were four times as many of these mites in each of the plots where the bands were undisturbed as in the plot where they were removed. The two treatments where *T. pyri* was abundant had slightly fewer *P. ulmi* throughout the season but these differences were not statistically significant. In 1955 the predators were approximately 15 times as numerous on plots II and III, where densities of 1.6 and 2.7 mites per leaf respectively were found, as on plot I, where the maximum density was 0.2 per leaf. Plot III had a higher density than II because it had received the bands that were removed from I during the winter. The numbers of both predators and prey were higher in 1955 than in 1954, probably partly because warm weather promoted development and partly as a legacy from the high numbers present the previous autumn. On plots where *T. pyri* was abundant the numbers of *P. ulmi* again were not significantly lower than on plots where the predator was scarce.

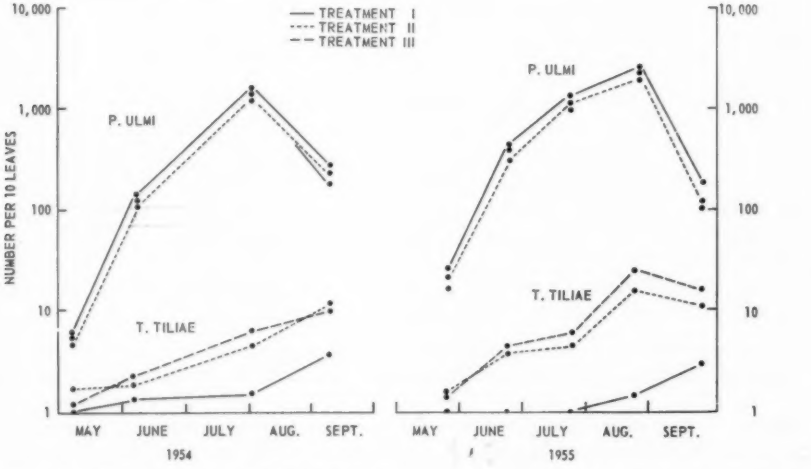


Fig. 22. Mean numbers of *T. pyri* (= *T. tiliae*) and *P. ulmi* during the summers of 1954 and 1955 in orchard where differential densities of *T. pyri* were obtained. (The vertical scale is logarithmic). The differences in *P. ulmi* density were not significant at the five per cent level.

The damage that *P. ulmi* caused to the apple foliage in the foregoing experiments was estimated (Blair, 1951) by an experienced, independent observer at the end of each season. Each tree was placed in a damage category ranging from 1 (no injury) to 6 (severe bronzing). The averages per tree for the three treatments present a clear picture of the damage that occurred (Table XI). The differences in damage apparent between the plots were not significant in either year, but in 1955 plot I seemed to be more severely damaged than the others. The mean per tree exceeded category 3 in every case, though the maximum damage tolerated by most commercial fruit growers in England is in the first or the second category. Therefore, control on all trees was unsatisfactory des-

pite the fact that a winter wash had been applied against *P. ulmi* eggs. The only other spray used was a 0.2 per cent lead arsenate spray applied uniformly to all treatments in each July to control the codling moth. No fungicides were used because most are toxic to *T. pyri* to some extent.

TABLE XI.

Damage caused by *P. ulmi* in P10 orchard and numbers of macropredators, 1954 and 1955*.

Plot	Mean damager per tree		Total macropredators per sample	
	1954	1955	1954	1955
I (*T. pyri* scarce)	3.4	4.0	9	36
II (*T. pyri* abundant)	3.5	3.0	7	30
III (*T. pyri* abundant)	3.0	3.1	9	34

*Differences not significant at one per cent level.

To show whether the effect of *T. pyri* on *P. ulmi* was masked or accentuated by the action of predacious insects, in July of each year all predacious insects were recorded from two of the guard trees in each replicate, a total of eight trees per treatment. Few macropredators were present on any plot in 1954, but in 1955 the predator density (chiefly composed of the mirid *Blepharidopterus angulatus* Fall.) was much greater; however, in each year the distribution of these insects was uniform on all plots (Table XI). Therefore, because the spray treatments and the effects of other predators were uniform, the results obtained probably present an accurate picture of the effect of *T. pyri* on *P. ulmi*.

The control exerted by *T. pyri* in this experiment over two years was slight and was much less than that desirable in commercial fruit plantations. In addition, a misleadingly favourable impression is obtained from the damage assessments shown in Table XI because in 1955 a large number of macropredators were present and these must have reduced the general level of infestation by *P. ulmi* considerably. If the only predator present had been *T. pyri*, damage might have been even more extensive and permanent injury to the trees might have resulted.

Thus, in one orchard *T. pyri* failed to satisfactorily control *P. ulmi* and effected only minor reductions in the pest population though it was present in larger numbers than are usually encountered in commercial orchards (Collyer and Kirby, 1955, claimed control of *P. ulmi* where the predator achieved a density of only 1.6 mites per leaf, and differentials were obtained by chemical means). These results are, of course, not conclusive, even for this species in southeastern England, and possibly over a period of years the predator might have achieved a more significant reduction of the pest. However, additional credence should be given to these results in view of the investigations described in earlier pages.

DISCUSSION

Early studies of phytoseiids were largely concerned with their occurrence in orchards in cohabitation with tetranychids and other phytophagous mite species. In the present study no such restrictions were imposed and phytoseiids were

investigated without particular reference to their possible economic importance. Consequently, the results presented here can be discussed along two lines, though both have the same basis. First, phytoseiids can be considered merely as organisms with certain inherent biological characteristics, and much time was devoted to this approach. Second, they also can be considered as predators of economically important species and it is necessary to assess their value in this regard.

The family Phytoseiidae is well represented in the study area in that 16 species were present. In general, they are moderately abundant and are found on almost every type of plant. Therefore their occurrence in orchards has no special significance. It is the present aim of most orchard entomologists to increase the abundance of beneficial species in this environment by manipulating the spray programs. It was shown by Huffaker and Kennet (1953, 1956) and Morgan and Anderson (1958) that both the composition and abundance of phytoseiid populations can be altered by chemical applications, so that in theory the precise manipulation of populations should be possible.

Phytoseiids in England overwinter as mature females on trees and evergreen plants, where no feeding apparently occurs. Winter mortality is great and may be the factor that limits their abundance; though it is not density-dependent, its catastrophic nature reduces the abundance to a very low level each year, and the low fecundity of the mites combined with the small number of summer generations prevents escape from this influence. Nicholson (1954) stated that such factors cannot truly regulate abundance, but merely determine the population level at which regulation takes place. Also contributing to this determination is the inherent restriction of low fecundity (Solomon, 1957, briefly discussed this matter). The regulation of population is probably by predacious insects and by cannibalism and these must be slightly density-dependent; it is difficult to investigate this matter because the catastrophic "legislative" effect of winter mortality requires only a small additional mortality for population regulation to occur, and this may be very unobtrusive in nature. From an economic point of view, however, winter mortality seems to be the factor that determines the population levels that can be achieved. In any event, the abundance of these mites seems to be fairly constant from year to year, and *T. pyri* rarely exceeds a density greater than two or three adults per leaf, though other species may be more numerous.

Various aspects of the life-histories and habits of several abundant species were discussed and it is shown that each species has its own requirements and characteristics. This implies that in studies on the predators of orchard-inhabiting tetranychids it is not sufficient merely to record "phytoseiids" or "typhlodromids"; rather, each species should be considered individually.

Studies on feeding provided further evidence of the need for detailed investigations. The fecundity and longevity of these mites varied according to the food supplied and also between species when the food supply was constant. Also, the capacities of several species for *P. ulmi* varied both during development and in the adult stage. In one species, the capacity of the male differed from that of the female during development and in *T. pyri* the adult males and nymphs apparently do not feed on *P. ulmi* as frequently as do females. This indicates that for critical field studies it is not even sufficient to consider a particular species as a whole, but rather that each should be studied in all its developmental stages.

Perhaps of greatest importance was the variety of food that was found to be acceptable to phytoseiids and that enables them to develop and lay eggs. Their predacious habits have been stressed in the past but the present study shows that

phytoseiids do not depend on other mites for food; development and oviposition can take place with certain plant foods.

Ullyett (1953) stated that any organism has, "as its aim, the survival of the greatest number of individuals of its population". This might better be stated as "any organism has, as its aim, the greatest possible exploitation of its environment". Ullyett's statement undoubtedly applies when restricted to individuals, and in a limited sense it is also true of populations; no species deliberately seeks extinction and, therefore, its limited function is to survive and reproduce. However, this does not mean that the measure of success of a population is the survival of the greatest number of individuals theoretically possible; this would be disastrous because in a very short time food and other necessary commodities of the environment would be exhausted and the population would have no alternative but to "crash" to a very low density. A species that experiences such a hectic procedure can only be considered as poorly adjusted to its environment, and it seems more reasonable to speculate that each organism has as its "aim" stability and freedom from the possibility of extinction. Stability implies adaptability and the ability to adjust to a changing environment, and this is lacking in cases where populations are forced by a changing environment (regardless of whether it was changed by the organism or by the variation of other factors) to great heights and dangerous depths.

Phytoseiids are very successful in achieving a stable state in England and their regulation seems to be accomplished with a minimum of conflict. In contrast, *P. ulmi* immediately exploits the slightest relaxation of environmental pressure, and its numbers increase. With *T. pyri*, however, a uniform population density is maintained over a period of years and the mite does not experience "outbreaks", which in a population sense are almost inevitably damaging. In short, from the studies reported above emerges the picture of a group of passive organisms in a sort of phlegmatic balance with their environment. Their requirements are not rigid; they are widely distributed on a varied range of host plants, and they probably never suffer from a shortage of food because such a great variety is acceptable and available.

In considering the predacious habit of phytoseiids and their possible value in the control of *P. ulmi*, the biological character of the pest should also be considered. Blair and Groves (1952) showed that *P. ulmi* has a comparatively great reproductive potential and has the ability to increase greatly in one season: it passes through at least five generations each year; it is parthenogenetic; and it frequently achieves densities of two or three hundred per leaf on apple and other cultivated fruits. It hibernates as an egg and winter mortality seems very low: Morgan (1952) estimated that temperatures as low as −35° or −40° F. must be experienced before mortality is severe.

If one attempts to conceive a picture of the ideal predator for the control of a pest such as this, the following characteristics must come to mind: the predator must have either a great ability to increase numerically or a large capacity for feeding on the pest; and it must prefer the pest to other foods, and yet it should be able to exist in the absence of the pest. These characteristics would allow either the effect or the density of the predator to increase at a faster rate than the prey until a point is reached where the mortality inflicted by the predator exceeds the rate of increase of the pest, and a reduction in pest population results.

There is, in fact, a considerable difference between the fecundity of the phytoseiid species studied, which lay approximately one egg every three or four days, and that of *P. ulmi*, which lays approximately one egg per day (Blair and

Groves, 1952). The number of generations (i.e., two to four) is less than that of *P. ulmi*, which has at least five in southeastern England, and this, together with the difference in fecundity, renders remote the possibility that the numbers of predators could fluctuate proportionally with those of the prey. Early workers tended to place their hopes for the biological control of phytophagous mites in phytoseiids because they believed that they and tetranychid mites have similar bionomics and ecology and therefore are well integrated (Gilliatt, 1935). This is not the case, however, and each possesses distinct and divergent characteristics.

Because the phytoseiids that were studied seem to be well adjusted to their environment, it is unlikely that "outbreaks" that would result in large numbers can occur. As implied above, extreme fluctuations in animal populations tend to indicate that the species concerned are in a very precise state of balance with their environment and fluctuate, or are made to fluctuate, too widely when compensating for adverse or favourable environmental influences. This intemperate sensitivity indicates a lack of adaptability (except in a numerical sense) and therefore a poor adjustment to the environment as a whole, and yet is a characteristic necessary for effective predators that lack the ability to feed more heavily at high than at low prey densities and therefore must tie themselves numerically to the fortunes of a species that may have become a pest mainly because of its own poor adjustment. Such a predator is, of course, extremely well-adjusted to the food species (in fact, it is completely dependent on it) but such extreme dependence indicates a lack of adaptability or adjustment to the environment as a whole, and does not seem to be a feature of phytoseiid life.

The capacity of phytoseiids for *P. ulmi* is apparently small. Solomon (1949) stated that small capacity for prey is in itself not necessarily a disadvantage and that the "importance of a control factor cannot be correctly estimated simply from the numbers or percentages of animals killed". That a predator could be important when killing only a few prey, however, is probably true only at or near the maximum density that the prey can attain in the circumstances that prevail. The small effect of a predator, such as phytoseiids, when added to other mortality factors, may tip the scales and cause a reduction. A predator such as this could also be important when it has the ability to become abundant in proportion to the prey.

Evidence was presented to show that in England phytoseiids can not keep pace numerically with their prey, nor is their effect intensified at high prey densities by means of increased feeding so that the destruction of prey disproportionally increases with prey density to the detriment of the prey. A wide range of food is acceptable, and even in the presence of dense prey populations additional sources of food may be utilized. In short, phytoseiids in England appear to be non-specific, facultative predators without marked preferences. Their effect may depend largely on the availability of other foods, on their searching and capture abilities, and on their preference for other foods. If one prey species is the only food present they feed exclusively on it, but the range of food available in most habitats dissipates their effectiveness as predators.

The general nature of the feeding habits of some predators of *P. ulmi* has been considered to enhance their effectiveness because it enables them to maintain themselves in the absence of any particular prey and they will therefore always be present (Kuenen, 1947; Collyer, 1953a and b; Pickett and Patterson, 1953; Collyer and Kirby, 1955). This can be true, however, only if the predator prefers *P. ulmi* and concentrates on it when it is abundant to the exclusion of other foods. DeBach (1951) stated that general predators feed on whatever food

is abundant and probably cannot effect control at economic levels, though they may retard rates of increase or reduce peak infestations when specific natural enemies of the pest have been reduced by other factors. This seems to be the case with phytoseiids, which apparently do not prefer *P. ulmi* for food to the exclusion of other material though of course they consume more of *P. ulmi* when it is abundant than when it is scarce.

Solomon (1949) also discussed this matter and concluded that the attacks of a polyphagous predator upon a particular population may depend mainly on the availability of alternative food and scarcely at all upon the density of the prey population. If other foods are present such a predator reaches its maximum capacity for destruction sooner than does a more specific, obligate predator. Solomon also stated that density-dependency is only achieved if the prey is essential to the maintenance of the predator. This is patently not the case with phytoseiids.

It has sometimes been suggested that predators unable to achieve control at high prey densities may be able to do so when the prey is less abundant. Therefore, if great densities of *P. ulmi* can be reduced by selective chemicals, phytoseiids and other predators of little value at high densities would be able to achieve and maintain control at economically acceptable levels. Little is known of predator-prey relationships at low prey densities but there seems no reason to suppose that the requirements that are necessary in the predator would be different under these circumstances. Unless density-dependency and all it involves is exhibited, the prey can eventually escape from control and balance may never be achieved.

In this regard, the difference between the distributions of *T. pyri* and *P. ulmi* in apple trees and on leaves must render the predator partially ineffective at any prey density because some portion of the prey is always free to increase unchecked. I consider this to be important and it is probably the single factor most responsible for the apparent failure of *T. pyri* to control *P. ulmi* and other mite species. This may not be true to the same extent for *T. finlandicus*, which may be more suitable than *T. pyri* as a predator of tetranychids. If so, this largely explains the contrast between the very low numbers of *P. ulmi* that occur in unsprayed orchards, where *T. finlandicus* is usually the dominant phytoseiid, and the much greater numbers that occur in cultivated orchards, where *T. pyri* is abundant.

The validity of these conclusions on the ability of *T. pyri* to control *P. ulmi* were supported under field conditions that minimized the possibility of chemical or other side-effects that may have a confusing or misleading influence. It was shown that, under these circumstances at least, *T. pyri* was unable to accomplish a significant reduction in *P. ulmi* density or in the damage it inflicted over two years. Records from habitats more nearly natural than orchards showed that in all but one instance phytoseiids also failed to achieve control of the prey species or to alter their population characteristics.

These characters, unfavourable to phytoseiids from an economic point of view, further contribute to the picture of a group of organisms well adjusted to their environment. Their feeding habits free them from dependency on other species and thus enable them to avoid the consequences of the intemperance of others, which is too often the fate of specific predators. Such independent animals do not seem to have the attributes necessary in predators of economic importance, and it is doubtful whether they could ever achieve "balance" with any one prey species, as the word *balance* implies dependency. In a population sense,

perhaps phytoseiids in England can best be considered as parasitic; they utilize other populations within their environment for their own purposes without having any great detrimental effect on them, and in this instance predation may be regarded as a product of population, rather than the reverse (Errington, 1946).

In summation then, I believe that the data presented here indicate that phytoseiids, with the possible exception of *T. finlandicus*, are of little actual or potential value in the control of orchard-inhabiting phytophagous mites in southeastern England. This conclusion is largely deductive and based on observations on the character of these mites, but "proof" was offered in one instance. It was certainly shown that phytoseiids are inefficient predators, and, though it does not necessarily follow that they are ineffective, field experimentation lent support to this view.

This, of course, is not necessarily true of other phytoseiid species in other parts of the world; one fact that emerges from the present study is that each species must be treated individually. Indeed, Huffaker and Kennet (1956) showed that *T. reticulatus* and *T. cucumeris* in California have many attributes that are greatly desirable in a predator, and there is little doubt that these species can effectively control the pest *Tarsonemus pallidus* on strawberry in that part of the world. However, in other places in the absence of precise information on the effects of predators their importance may well have been exaggerated and the present investigation emphasizes the need for critical studies to test the validity of unsupported statements such as have been made in the past. The two steps necessary when studying predator-prey relationships from an economic standpoint have already been mentioned; generally speaking, at present we appear to be in transition from demonstrating the predacious habits of predators of phytophagous mites to proving the validity of the interpretation of our empirical observations.

Summary

For 50 years mites of the family Phytoseiidae have been recognized as predators of phytophagous orchard-inhabiting mites, though our knowledge concerning them is slight. This paper is a study of phytoseiids in southeastern England.

Phytoseiids are widely distributed in the study area. None exhibits plant-specificity, though they may show a preference for certain habitats. Each species overwinters as adult females, some on evergreen plants, others in bark crevices. Winter mortality is severe.

Though *T. pyri* is predacious on *P. ulmi* and other small acarines, plant food such as fungi and pollen is acceptable and allows both development and reproduction. These activities do not occur when only apple leaves are provided as food, though a small number of *P. ulmi* larvae initially eaten is sufficient to permit the phytoseiids to complete development with no other food than leaves. In the absence of plant material, approximately 25 *P. ulmi* larvae are required for development.

Insectary rearings established the developmental times of four common species. A field population of *T. pyri* Scheuten was studied in 1954 and 1955 and in 1955 several other species were also studied. Various aspects of the ecology of *T. pyri* were studied and related to those of its prey, *Panonychus ulmi* (Koch), showing that the predator is inefficient and partially ineffective. These results were substantiated by field experimentation.

Part II

A TAXONOMIC REVIEW OF THE FAMILY PHYTOSEIIDAE, WITH DESCRIPTIONS OF 38 NEW SPECIES

Introduction

After being elevated to family rank from subfamilial rank in the family Laelaptidae the family Phytoseiidae was considered to contain two subfamilies, the Phytoseiinae and the Podocininae (Baker and Wharton, 1952). Evans (1957) subsequently elevated the Podocininae to family rank but the original number of subfamilies was restored by the description of a new subfamily, Macroseiinae, by Chant *et al.* (1959). The subfamily Macroseiinae contains but one species, a highly specialized form that inhabits the pitcher plant, *Sarracenia* sp., in Florida. The subfamily Phytoseiinae contains the genera *Typhlodromus* Scheuten (= *Iphidulus* Ribaga, *Amblyseius* Berlese, *Amblyseiopsis* Garman, *Neoseiulus* Hughes, and *Amblyseiella* Muma), *Phytoseius* Ribaga, *Phytoseiulus* Evans, *Iphiseius* Berlese, *Seiulus* Berlese, *Asperoseius* Chant, *Proprioseius* Chant, and *Typhloseiopsis* De Leon.

These mites are considered to be largely predacious and are therefore of interest to economic acarologists and entomologists. Those of greatest agricultural and horticultural importance are in the first three genera listed; the mites of the remaining genera are only of minor economic importance.

Nesbitt (1951) reviewed the subfamily Phytoseiinae and included in it the genera *Garmania* Nesbitt, *Blattisocius* Keegan, and *Kleemania* Oudms.; but Evans (1957) transferred these three genera to the Family Aceosejidae Baker and Wharton and considered the family Phytoseiidae to comprise those mites that have the specialized seta on the palptarsus with two prongs (rather than three or four), that have the dorsal shield entire, with 20 or fewer pairs of setae, that have a ventrianal shield, and that have the genital shield truncate in the female. Others have criticized Evans because the criteria he used to separate the Phytoseiidae from the Aceosejidae in his paper appear to be artificial and insignificant. However, his morphological distinction between the two families is strongly supported by ecological differences; the Phytoseiidae are almost completely plant-inhabiting mites, whereas the Aceosejidae inhabit stored food products, decaying plant and animal material, animal cultures, and soil. Several acarologists (*in litt.*) suggested to me that *Amblyseius* (*Seiopsis*) *brevipilus* Berlese, 1923, should be included in the family Phytoseiidae. I examined the type specimen of this species (slide no. 210/45 in the Berlese Collection, Florence, Italy) and found that it belongs to the family Aceosejidae. Nesbitt reduced Hughes' (1948) genus *Neoseiulus* to subgeneric level but I consider even this arrangement to have been artificial and have dispensed with the subgenus in the present paper. Athias-Henriot (1957a) included the genus *Indoseius* Evans in the family Phytoseiidae but Evans' descriptions and drawings show it to belong to the Aceosejidae.

Nesbitt described and figured the 19 species of the genera *Typhlodromus* and *Phytoseius* then known. Now more than 100 species of these genera alone are known. This increase was a result partially of the many descriptions of new species that have appeared during the last five years (Evans, 1952, 1953, 1954; Womersley, 1954; Muma, 1955b; Chant, 1955, 1956, 1957a) and partially of generic revision by Chant (1957b), who combined the genera *Amblyseiella* Muma and *Amblyseiopsis* Garman with *Amblyseius* Berlese, and the genus *Amblyseius* with *Typhlodromus*, greatly increasing the number of known species in the last.

Because the number of species has increased so greatly it is now difficult for workers to identify their own material. To rectify this situation, distinguishing characters of all previously described species of the family are given below together with descriptions of 38 new species and keys to the adult females of all known species. In the two subgenera of *Typhlodromus* the species are arranged in groups that are based on morphological features and that emphasize similarities between closely related forms. The groups were given the names of the earliest described species they contain. The downgrading of *Amblyseius* has been objected to because many species in *Amblyseius* are very heavily sclerotized and globular in shape, and much different from the species in *Typhlodromus*. It should be realized, however, that these forms represent an extreme *Amblyseius* type (mostly ground-inhabiting) and that a gradation between these and the lightly sclerotized species that are similar to many *Typhlodromus* species can be demonstrated. Athias-Henriot (1958) objected to this downgrading because she felt the character used to distinguish between the two subgenera "étant d'ordre supragénérique, les groupes qui diffèrent par ce caractère doivent être séparés à l'échelon générique". Admittedly, this is a matter of opinion but if acarologists erected new genera for every phytoseiid that lacks one or more lateral setae we would soon be inundated with new names and the purpose of systematics would be defeated. Basically similar and related species would be separated by a generic barrier. For example, see p. 62 for a discussion of *T.* (*T.*) *pyri* and *T.* (*T.*) *rhenanus*.

Nesbitt (1951) described the morphology and taxonomy of phytoseiid mites. Garman's (1948) system of setal nomenclature was followed by later authors and is used in this paper with some modifications. Evans (1953) objected to its use on the ground that it does not allow for changes during development and therefore cannot be used for immature forms. However, in the present paper only the adults are considered. The system was modified slightly for the subgenera *Typhlodromus* and *Amblyseius* as shown in Figs. 23-25. Garman numbered the lateral setae on the dorsal shield from L_1 to whatever number was present, as in Figs. 23 and 25. In the subgenus *Typhlodromus* the number of lateral setae varies from eight to 12 and here Garman's system is followed. However, in the subgenus *Amblyseius* the basic number of lateral setae is always nine and they are always arranged as shown in Fig. 23, namely: setae L_1 to L_4 (the anterior lateral setae) form a discrete group; there is a gap and then setae L_5 and L_6 are found close together, with L_5 always mesad of L_6; L_7, L_8, and L_9 are always grouped on the posterior margin of the dorsal shield and associated with M_2. Species are known in which one or more lateral setae are absent but it is always possible to determine which is or are missing by the positions of the remainder. For example, in *T.* (*A.*) *grandis* (Berlese) both L_7 and L_8 are absent, and in *T.* (*A.*) *aberrans* Oudemans L_7 is absent. In species such as these the setae were named as if the missing setae were present; e.g., the ultimate seta is always L_9 and if, for example, L_7 is absent, the penultimate seta is numbered L_8, rather than L_7 as with Garman's system (see Fig. 24).

Garman's system was followed with the other genera of the family because there is no basic setal pattern and it is impossible to determine which setae are missing if there are fewer than usual.

Two main criteria are used for the separation of both genera and species: the chaetotaxy of the dorsal shield, and the chaetotaxy and shape of the ventrianal shield of the adult female. The former is the more significant for generic separation and it is used extensively in this paper. Several distinct forms of mites are

evident and these can be separated on the basis of the character of the setae on the dorsal shield, — i.e., whether these are slender and smooth, or long and serrated, or long, very thickened, and serrated (see keys). A classification could be based on the ventrianal shield alone, but it cannot be justified because the members of the groups that result have widely different dorsal characters. Similarly, within groups based on dorsal characters there are many different types of ventrianal shields but these show intergrades between characters and it is logical to assume that within each of these groups the ventrianal shields have become progressively modified. This is not true of the dorsal shields when a classification is based on ventral characters because links between the various forms cannot be demonstrated and the system is arbitrary. For example, Evans (1953) described a new genus, *Phytoseiulus*, with slender, serrated, very long setae on the dorsal shield and with only one pair of pre-anal setae on the ventrianal shield. Muma (1955b) also described a species with only one pair of setae on the ventrianal shield and on the basis of the shield alone this species should be placed in the genus *Phytoseiulus*, as Garman (1958) has done. However, its dorsal shield is altogether unlike that of the type species. When the species is placed in *Typhlodromus* the character of the ventrianal shield completes a series in which the shields are progressively modified from those with three pairs of preanal setae to those with only one pair. Therefore, the latter assignment is the more natural and useful on the basis that a major purpose of classification is to emphasize similarities as well as differences and thus to indicate relationships.

Phytoseiid mites show little intraspecific variation and the criteria for specific separation, though appearing to be of minor importance, can usually be used with confidence. The same characters are used for specific as for generic separation, but in addition the relative lengths of certain setae on the dorsal shield (as opposed to setal pattern and character) are used. For example, the relative lengths of setae L_2 and L_3 and of L_5 and L_6 are significant in the subgenus *Amblyseius*. Another valuable character for specific separation is the chaetotaxy of the membrane that surrounds the ventrianal shield. The chelicerae and peritremata are described in this paper whenever possible as these may sometimes be of value for separating species, though this is not fully substantiated because it has not been demonstrated that these features are constant within species. In most instances specimens must be virtually destroyed to examine details of these structures. Adult males are of little taxonomic value, partly because differentiation in ventral characters between species is slight: the ventrianal shields of all males are of the same shape and they have only four or five types of setal patterns. Therefore, the males must be separated almost entirely on dorsal characters. For this reason they are not included in the keys presented below.

Several authors have used other criteria for specific separation, such as the shape and relative lengths of the metapodal plates and the appearance and positions of the pores on the ventrianal shield. I object to use of the former on the ground that these small plates are flat, and may be found in almost any plane depending on how tightly the cover slip of the microscopic preparation presses against the specimen. The latter cannot be used with confidence because the function of these pores is unknown, and their character may depend upon the condition of the specimen, i.e., whether it is full-fed or starved, and whether or not it is gravid.

Many of the records of geographical distribution given below and most of the new species described herein were from the collection of the United States National Museum. Host plant records are not given because most phytoseiids are not host-specific. Anderson *et al.* (1958) pointed out that members of the

subgenus *Amblyseius* prefer grasses and other herbaceous plants whereas members of the subgenus *Typhlodromus* prefer woody plants.

The author examined the type specimens of most of the species discussed below on visits to the United States National Museum, Washington, D.C., the Canadian National Collection, Ottawa, the Connecticut Agricultural Experiment Station, New Haven, the British Museum (Natural History), London, the Rijksmuseum van Natuurlijke Historie, Leiden, the Stazione di Entomologia Agraria, Florence, and the Los Angeles County Museum. The types of Womersley's species are in the Canadian National Collection and these were examined.

Mites were examined in mounts of Berlese's, Faure's, or polyvinyl-lactophenol media. Drawings were made with a camera lucida if specimens were available; otherwise they were reconstructed from the original author's descriptions and illustrations. Whenever possible, measurements of the new species are the average of 10 specimens.

Key to Subfamilies of the Family Phytoseiidae

1. Dorsal shield subdivided ..... Macroseiinae Chant, Denmark, & Baker
   Dorsal shield entire ..... Phytoseiinae Berlese

Subfamily Phytoseiinae Berlese

Key to Genera of the Subfamily Phytoseiidae

1. Interscutal membrane sclerotized; ventrianal shield sometimes fragmented to form anal and ventral shields (Fig. 26) ..... *Iphiseius* Berlese
   Interscutal membrane not sclerotized; ventrianal shield usually entire, not fragmented (Fig. 27) 2
2. Ventrianal shield entire 3
   Ventrianal shield much reduced, only an anal plate with para-anal setae remaining ..... *Typhloseiopsis* De Leon
3. Some setae on dorsal shield serrated, club-shaped or flattened (Figs. 265, 267) 4
   Some setae on dorsal shield serrated, but not club-shaped or flattened, or simple (Figs. 251, 44) 5
4. Some setae on dorsal shield club-shaped (Fig. 267) ..... *Proprioseius* Chant
   Some setae on dorsal shield flattened (Fig. 265) ..... *Asperoseius* Chant
5. Most setae on dorsal shield not greatly serrated, sometimes short (Figs. 44, 62, 66) 7
   Most setae on dorsal shield highly serrated, long (Figs. 251, 257) 6
6. Dorsal setae (D) minute, not serrated; setae S_1 on dorsal shield near L_4 and L_5 (Fig. 251); one to three pairs of setae on ventrianal shield ..... *Phytoseius* Ribaga
   Dorsal setae (D) long and serrated; setae S_1 on interscutal membrane (Fig. 257); one pair of pre-anal setae or none on ventrianal shield of female ..... *Phytoseiulus* Evans
7. Lateral setae mostly thickened, thornlike (Fig. 271) ..... *Seiulus* Berlese
   Lateral setae not thickened, not thornlike (Fig. 38) ..... *Typhlodromus* Scheuten

Genus *Typhlodromus* Scheuten

Typhlodromus gen.n. Scheuten, 1857: 111.
Iphidulus gen.n. Ribaga, 1902: 176 (type species, *I. communis* by original designation.)
Amblyseius gen.n. Berlese, 1914: 143 (type species, *A. obtusus* by original designation.)
Neoseiulus gen.n. Hughes, 1948: 141 (type species, *N. barkeri* by original designation.)
Seiopsis subgen.n. Berlese, 1923: 255.
Amblyseiopsis subgen.n. Garman, 1948: 17 (type species *Amblyseius* (*Amblyseiopsis*) *americanus*).
Amblyseiella gen.n. Muma, 1955: 266 (type species, *A. setosa* by original designation.)
Amblyseiopsis Garman, Muma, 1955: 264 (generic status).

Type species, by monotypy: *Typhlodromus pyri* Scheuten, 1857.

Diagnosis—Dorsal shield with 13 to 20 pairs of setae, six to 12 in the lateral rows. If some setae on dorsal shield long, not flattened, club-shaped, greatly thickened, or serrated, but slender and smooth. Setae S_1 and S_2, if present, on interscutal membrane. Ventrianal shield of various shapes, with one to four pairs of pre-anal setae.

Key to Subgenera of *Typhlodromus*

1. Four pairs of anterior lateral setae on dorsal shield (Fig. 23); never more than nine pairs of lateral setae ..... *Amblyseius* Berlese
   More than four pairs of anterior lateral setae on dorsal shield (Fig. 25); eight to 12 pairs of lateral setae ..... *Typhlodromus* Scheuten

SUBGENUS *Typhlodromus* SCHEUTEN

Key to Groups of the Subgenus *Typhlodromus*

1. Eight pairs of lateral setae on dorsal shield 2
   More than eight pairs of lateral setae on dorsal shield 4
2. Two pairs of pre-anal setae on ventrianal shield ..... *smithi* group
   Four pairs of pre-anal setae on ventrianal shield 3
3. Setae L_2 and L_4 minute; leg IV with three long macrosetae ..... *contiguus* group
   Setae L_2 and L_4 not minute; leg IV sometimes with short macrosetae ..... *conspicuus* group
4. Nine pairs of lateral setae on dorsal shield 5
   More than nine pairs of lateral setae on dorsal shield 8
5. Three pairs of pre-anal setae on ventrianal shield ..... *validus* group
   Four pairs of pre-anal setae on ventrianal shield 6
6. Setae L_8 and L_9 the only lateral setae on posterior third of dorsal shield (Fig. 52); seta L_8 much closer to L_9 than to L_7; setae on dorsum short ..... *pomi* group
   Setae on dorsal shield not arranged as above 7
7. Bases of setae L_8 and M_2 closer to each other than to bases of other setae; setae on dorsum short ..... *T.* (*T.*) *pyri* (*rhenanus* group)
   Bases of setae L_8, L_9 and M_2 equidistant; setae on dorsum very long (Fig. 64) ..... *occidentalis* group
8. Ten pairs of lateral setae on dorsal shield 9
   More than 10 pairs of lateral setae on dorsal shield 11
9. Two pairs of pre-anal setae on ventrianal shield; three pairs of setae in median rows on dorsal shield (Fig. 66) ..... *soleiger* group
   More than two pairs of pre-anal setae on ventrianal shield; two pairs of setae in median rows on dorsal shield (Fig. 76) 10
10. Three pairs of pre-anal setae on ventrianal shield ..... *barkeri* group
    Four pairs of pre-anal setae on ventrianal shield ..... *rhenanus* group
11. Eleven pairs of lateral setae on dorsal shield ..... *tiliarum* group
    Twelve pairs of lateral setae on dorsal shield ..... *australicus* group

T. smithi Group

Dorsal shield with eight pairs of lateral setae, of which L_7 and L_8 are the only lateral setae on its posterior third (Fig. 28). Ventrianal shield with two pairs of pre-anal setae. Only one known species.

T. (T.) smithi Schuster (Figs. 28, 29)

Typhlodromus smithi Schuster, 1957: 203-205; Plate I.

Holotype in California Academy of Sciences.

Paratypes at University of California, Davis, and Entomology Laboratory, Belleville.

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 28). Lateral setae equal to or longer than distances between their bases. Seta M_2 longer than distance between its base and that of L_7. Two pairs of sacral setae on interscutal membrane. Ventrianal shield longer than wide, rectangular, and with two pairs of pre-anal setae (Fig. 29). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Collected in California. The ventrianal shield is unique among the members of the subgenus *Typhlodromus*. Type locality: Victor, San Joaquin Co., California.

T. contiguus Group

Dorsal shield with eight pairs of lateral setae, of which L_7 and L_8 are the only lateral setae on the posterior third. Setae L_2, L_4, and L_7 minute. Leg IV

with three long macrosetae. Ventrianal shield with four pairs of pre-anal setae. Only one known species.

***T. (T.) contiguus* Chant (Figs. 303, 304)**

Typhlodromus (Typhlodromus) contiguus Chant, 1959: 29-31; Figs. 1-6.

Holotype in Canadian National Collection (No. 6709); paratypes to be deposited in the United States National Museum and the Citrus Experiment Station, Riverside California.

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 303). Setae D_1, L_1, L_3, L_5, L_6, L_8, and M_2 long, remaining setae minute. Ventrianal shield with four pairs of pre-anal setae (Fig. 304). Two pairs of metapodal plates. Three pairs of setae on membrane surrounding ventrianal shield. Leg IV with three long macrosetae. Collected in Hong Kong and the Philippine Islands. Type locality: citrus leaves, Taipo, Hong Kong.

This species superficially resembles several members of the *T. conspicuus* group. In the original description of *T. (T.) contiguus*, however, it was pointed out that it has many features of the subgenus *Amblyseius*. The more important of these separate the species from the *T. conspicuus* group and these are: the dentition of the chelicerae; the relative lengths of the lateral setae on the dorsal shield; and the chaetotaxy of the legs.

***T. conspicuus* Group**

Dorsal shield with eight pairs of lateral setae, of which L_7 and L_8 are the only lateral setae on its posterior third (Fig. 30). Ventrianal shield with four pairs of pre-anal setae. Separation of species largely based on relative lengths of setae on dorsal shield, in some instances also on modifications of the shape of the ventrianal shield.

Key to Species of *conspicuus* Group

1. Anterior lateral setae on dorsal shield not longer than distances between their bases (Fig. 38) 2
   Anterior lateral setae on dorsal shield longer than distances between their bases (Fig. 40) 8
2. Two pairs of setae on membrane surrounding ventrianal shield 3
   Three pairs of setae on membrane surrounding ventrianal shield 4
3. Setae L_8, M_2 short (Fig. 281) ..... *T. (T.) anchialus* Kennett
   Setae L_8, M_2 longer (Fig. 38) ..... *T. (T.) columbiensis* sp.n.
4. Ventrianal shield almost square; all setae on dorsal shield serrated (Fig. 30) 5
   Ventrianal shield much longer than wide, approximately rectangular (Fig. 37); most setae on dorsal shield smooth, though L_8 and M_2 sometimes serrated 6
5. Seta M_2 longer than distance between its base and that of L_8 (Fig. 273) ..... *T. (T.) alveolaris* De Leon
   Seta M_2 shorter than distance between its base and that of L_8 (Fig. 30) ..... *T. (T.) burrelli* sp.n.
6. Seta M_2 short (Fig. 36) ..... *T. (T.) pini* Chant
   Seta M_2 long (Fig. 32) 7
7. Setae L_8 and M_2 serrated; lateral margins of ventrianal shield parallel, shield without a waist (Fig. 33) ..... *T. (T.) perplexus* sp.n.
   Setae L_8 and M_2 smooth; lateral margins of ventrianal shield constricted and forming a waist (Fig. 35) ..... *T. (T.) arboreus* Chant
8. Setae on dorsal shield, except D_1, D_2, and D_6, very long (Fig. 40); seta S_2 absent ..... *T. (T.) pilosus* sp.n.
   Setae on dorsal shield only moderately long (Fig. 46); seta S_2 on interscutal membrane 9
9. Anterior lateral setae slightly longer than distances between their bases (Fig. 46) 10
   Anterior lateral setae much longer than distances between their bases (Fig. 44) 11

10. Setae M_2, L_8 smooth; L_1 longer than L_2 (Fig. 46) ..... *T. (T.) herbertae* sp.n.
Setae M_2, L_8 serrated; L_1 approximately equal to L_2 (Fig. 275) ... *T. (T.) cornus* De Leon
11. Many setae on dorsal shield serrated (Fig. 42); juncture of lateral and anterior margins of ventrianal shield angular (Fig. 43) ..... *T. (T.) tropicus* sp.n.
Setae on dorsal shield smooth (Fig. 44); juncture of lateral and anterior margins of ventrianal shield rounded (Fig. 45) ..... *T. (T.) conspicuus* (Garman)

***T. (T.) anchialus* Kennett (Figs. 281, 282)**

Typhlodromus anchialus Kennett, 1958: 473-474; Figs. 6-12.

Holotype in United States National Museum.

Dorsal shield (Fig. 281) with 16 pairs of setae, eight in the lateral rows. Anterior lateral setae approximately equal to or slightly shorter than distances between their bases. Seta M_2 shorter than distance between its base and that of L_8. Seta L_7 very short. Seta L_8 slightly longer than M_2. Sternal shield with two pairs of setae, third and fourth pairs on metasternal plates. Ventrianal shield (Fig. 282) much longer than wide, constricted anteriorly, with four pairs of pre-anal setae and a pair of pores. Only two pairs of setae on membrane surrounding ventrianal shield. Basitarsus IV with macroseta. Collected in California. Type locality: strawberry leaves, Watsonville, California.

***T. (T.) burrelli* sp.n. (Figs. 30, 31)**

Female.—Length 334 μ; width 170 μ. Dorsal shield reticulated and with 16 pairs of setae: eight in the lateral, two in the median, and six in the dorsal rows (Fig. 30). All setae short (under 25 μ) except L_8 and M_2 (47 and 32 μ respectively). All setae serrated. Setae L_7 and L_8 the only lateral setae on posterior third of dorsum. Seta M_2 not associated with any lateral setae.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad with slender, truncate, posterior projection curving slightly around base of coxa IV. Sternal shield normal, with three pairs of setae. Small metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (105 μ) than wide (89 μ), with lateral margins nearly parallel, anterior margin straight, with four pairs of setae in addition to para-anals and with a distinct pair of pores (Fig. 31). Three pairs of setae on membrane surrounding ventrianal shield, one (VL_1) moderately long (27 μ) and serrated, the remainder short and smooth. Two pairs of metapodal plates present, one much larger than the other.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with two teeth and pilus dentilis; movable digit without teeth. Legs normal and without specialized setae.

Male.—Ventrianal shield with three pairs of pre-anal setae. Chelicera with long, slender, unbranched spermatophoral process.

Diagnosis.—Distinguished from other species of the group by the serration and shortness of the setae on the dorsal shield and by the shape of the ventrianal shield.

Locality and Type Material.—The holotype female and 16 additional females and three males were collected from cypress leaves at the Louisiana State University, Baton Rouge, Louisiana, on May 29, 1953, by Mr. R. W. Burrell, and are in the U.S. National Museum. Another female, collected from a tangerine leaf at Luna Grove, near Weslaco, Texas, on May 1, 1953, by Dr. H. A. Dean, is in the Canadian National Collection at the Belleville laboratory. The species has also been collected from magnolia leaves at Baton Rouge.

***T. (T.) perplexus* sp.n. (Figs. 32, 33)**

Female.—Length 331 μ; width 190 μ. Dorsal shield moderately reticulated and with 16 pairs of setae: eight in the lateral, two in the median, and six in the

dorsal rows (Fig. 32). Setae L_8 and M_2 serrated and moderately long (52 and 32 μ respectively). Remaining setae smooth and much shorter than distances between their bases. Setae L_7 and L_8 the only lateral setae on the posterior third of shield. Shield with marked lateral indentation immediately posterior to seta L_6.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad, with sharply hooked, truncate, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Oval metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (104 μ) than wide (81 μ), nearly oblong, with anterior margin straight, lateral margins nearly parallel, and posterior margin rounded, and with four pairs of setae in addition to para-anals (Fig. 33). Three pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (41 μ), the remainder short. Two pairs of metapodal plates present, one large and the other minute.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with a single tooth and pilus dentilis; movable digit with one tooth. Legs normal and without specialized setae.

Male.—Unknown.

Diagnosis.—Distinguished from other species that have eight pairs of lateral setae on the dorsum by the length of these setae, by the serration of setae M_2 and L_8, and by the shape of the ventrianal shield.

Locality and Type Material.—Holotype and three other female specimens, collected from ash (*Fraxinus* sp.) at Mercedes, Texas, March 9, 1955, by Paul T. Riherd, are in the U.S. National Museum. One female is in the Canadian National Collection at the Belleville laboratory.

T. (*T.*) *arboreus* Chant (Figs. 34, 35)

Typhlodromus arboreus Chant, 1957a: 292; Figs. 8, 9.

Holotype in Canadian National Collection (No. 6540).

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 34). Lateral setae shorter than distances between their bases, and smooth. Seta M_2 as long as distance between its base and that of L_7. Seta L_7 much shorter than L_8. Ventrianal shield much longer than wide, with anterior corners rounded, a distinct waist, and four pairs of pre-anal setae (Fig. 35). Three pairs of setae on membrane surrounding ventrianal shield. Leg IV with one macroseta. One pair of small, subsidiary, sclerotized plates on membrane between ventrianal and genital shields. Two pairs of metapodal plates. Collected in British Columbia and Florida. Type locality: apple leaves, 1650 Wesbrook Crescent, Vancouver, British Columbia.

T. (*T.*) *alveolaris* De Leon (Figs. 273, 274)

Typhlodromus alveolaris De Leon, 1957: 141; Figs. 1-3.

Holotype in De Leon's collection, Coral Gables, Florida.

Dorsal shield (Fig. 273) with 16 pairs of setae, eight in the lateral rows. Setae L_1 to L_5 shorter than distances between their bases. Setae M_2, L_8 thick, long (62 and 83 μ respectively), very serrated; M_2 longer than distance between its base and that of L_8. Setae L_7, D_1 to D_6, M_1 minute. Seta S_2 absent. Ventrianal shield rectangular, longer than wide, with slight waist, and with four pairs of pre-anal setae and a pair of pores. Legs without macrosetae. Collected only in Florida. Type locality: *Cassia* sp. leaves, Coral Gables, Florida.

T. (T.) pini Chant (Figs. 36, 37)

Typhlodromus pini Chant, 1955: 501-502; Fig. 4.
Typhlodromus citri Garman & McGregor, 1956: 8-11; Plate 4, Figs. 1-6. *New synonymy* (on lemon, Whittier, California).
Typhlodromus pacificus McGregor, 1957: 8-9; Plate II, Figs. 8, 9. *New synonymy* (on lemon, Corona, California).

Holotype in British Museum (Natural History).
Paratypes in Canadian National Collection.

McGregor's type specimens were examined in the Los Angeles County Museum and it was found that *T. (T.) citri* is a synonym of *T. (T.) pini*. McGregor believed his *T. (T.) pacificus* to be the same as *T.* "new species" Cunliffe & Baker but his holotype is identical with *T. pini* and these names are synonymous. Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 36). Lateral setae shorter than distances between their bases. Seta M_2 much shorter than distance between its base and that of seta L_7. Seta L_7 much shorter than L_8. Ventrianal shield much longer than wide, with anterior margin rounded, with a distinct waist, with anus farther anteriad than normally, and with four pairs of pre-anal setae (Fig. 37). Three pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with one macroseta. Collected in British Columbia, Washington, California, and Mexico. Type locality: bark of *Pinus contorta* Dougl., Vancouver, British Columbia.

T. (T.) columbiensis sp.n. (Figs. 38, 39)

Female.—Length 365 μ; width 190 μ. Dorsal shield slightly reticulated, with 16 pairs of setae, eight in the lateral, two in the median, and six in the dorsal rows (Fig. 38). All setae smooth, all except L_8 and M_2 short (59 and 42 μ respectively). Base of seta M_2 much closer to that of L_7 than to that of L_6. Setae L_7 and L_8 the only lateral setae on posterior third of shield. Setae L_1 to L_6 shorter than distances between their bases. Seta M_2 longer than distance between its base and that of L_7.

Setae S_1 and S_2 on interscutal membrane. Peritreme with short, posterior projection curving not quite around base of coxa IV. Sternal shield normal, with three pairs of setae. Oval metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (108 μ) than wide (72 μ), triangular with conspicuous indentations in lateral margins, with four pairs of setae in addition to para-anals (Fig. 39). Two pairs of setae on membrane surrounding ventrianal shield. Three pairs of metapodal plates, one extremely small.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of position of specimen. Legs normal, with one macroseta on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the relative lengths of the setae on the dorsal shield, by the shape of the ventrianal shield, and by the chaetotaxy of the posterior ventral surface of the body.

Locality and Type Material.—A single female specimen collected from wild cherry five miles west of Keremeos, British Columbia, July 12, 1956, by the author, is in the Canadian National Collection (No. 6851).

T. (T.) pilosus sp.n. (Figs. 40, 41)

Female.—Length 342 μ; width 185 μ. Dorsal shield reticulated, with 16 pairs of setae, eight in the lateral, two in the median, and six in the dorsal rows (Fig. 40). All setae longer than 55 μ and longer than distances between their bases, except D_1, D_2, and D_6, which are short or minute. Bases of setae L_7, L_8, and M_2 forming a triangle with approximately equal sides.

Seta S_1 on interscutal membrane; S_2 absent. Peritreme narrow with scimitar-shaped, truncate, posterior projection curving sharply around base of coxa IV. Sternal shield normal, with three pairs of long setae. Large metasternal plates with a fourth pair of setae. Genital shield reticulated and with a pair of long setae. Ventrianal shield reticulated, only slightly longer (103 μ) than wide (92 μ), with posterior margin rounded, anterior margin nearly straight, lateral margins concave, with four pairs of setae in addition to para-anals, and with a pair of pores (Fig. 41). In some specimens the chaetotaxy of the ventrianal shield is variable and some pre-anal setae are beside the shield instead of on it. Two pairs of setae on membrane surrounding ventrianal shield (50 to 60 μ long). Two pairs of long, slender metapodal plates. Two pairs of small, secondary, sclerotized plates on membrane between ventrianal shield and metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with three small teeth and pilus dentilis; movable digit with one tooth. Legs normal and without specialized setae.

Male.—Unknown.

Diagnosis.—Distinguished by the extreme length of the setae on the dorsal shield and by the shape and character of the ventrianal shield.

Locality and Type Material.—The holotype and three additional females were collected from cotton leaves at Chinandega, Nicaragua, February 11, 1952, by Mr. Swain, and are in the U.S. National Museum. Three females collected from roses and *Sombria japonesa* at Santa Tecla, El Salvador, February 21, 1952, by Mr. P. A. Berry, are in the Canadian National Collection at the Belleville laboratory.

***T. (T.) tropicus* sp.n. (Figs. 42, 43)**

Female.—Length 352 μ; width 230 μ. Dorsal shield reticulated, with 16 pairs of setae, eight in the lateral, two in the median, and six in the dorsal rows (Fig. 42). Except L_7 all setae slightly serrated. Lateral setae long, ranging from 18 μ (L_2) to 68 μ (M_2) and 59 μ (L_7). Seta L_7 very long, longer than L_8. A faint pair of pores associated with seta L_8. Setae L_7 and L_8 the only lateral setae on posterior third of shield. Seta M_2 not associated with any lateral setae.

Setae S_1 and S_2 on interscutal membrane. Peritreme narrow, with short, hooked, posterior projection. Sternal shield with three pairs of setae, the third pair on projections that are almost separated from the shield proper. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (117 μ) than wide (77 μ), with anterior margin straight, lateral margins slightly concave, posterior margin rounded, with four pairs of setae in addition to para-anals, and with a pair of pores (Fig. 43). Three pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (59 μ) and slightly serrated, the remainder short and smooth. Two pairs of metapodal plates, one long and slender, the other short. A transverse fold lying between ventrianal and genital shields.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, without specialized setae.

Male.—Unknown.

Diagnosis.—Distinguished by the length and character of the setae on the dorsum, and by the shape of the ventrianal shield.

Locality and Type Material.—A single female, collected from chiromoya leaves, Guaillabamba, Ecuador, February 26, 1953, is in the Canadian National

Collection (No. 6852). Dr. E. W. Baker collected further specimens in Central America in 1959.

***T. (T.) conspicuus* (Garman) (Figs. 44, 45)**

Iphidulus conspicuus Garman, 1948: 14; Fig. 6.
Typhlodromus conspicuus (Garman), Nesbitt, 1951: 22; Figs. 9, 22.
Typhlodromus conspicuus (Garman), Cunliffe and Baker, 1953: 11; figures.

Holotype in Connecticut Agricultural Experiment Station collection, New Haven.

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 44). All setae long and smooth. Ventrianal shield much longer than wide, with anterior corners rounded, and with four pairs of pre-anal setae (Fig. 45). Three pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Legs without macrosetae. Collected in many parts of Canada and the United States, and apparently more common in the East than in the West. Probably a bark-inhabiting species. Type locality: apple bark, Hamden, Connecticut.

***T. (T.) cornus* De Leon (Figs. 275, 276)**

Typhlodromus cornus De Leon, 1957: 142-143; Figs. 4-7.

Holotype in De Leon's collection, Coral Gables, Florida.

Dorsal shield (Fig. 275) with 16 pairs of setae, eight in the lateral rows. Setae L_1 to L_5 equal to or slightly longer than distances between their bases. Setae D_1 to D_5, M_1 short, not minute. Setae D_6, L_7 minute. All setae thick, M_2, L_8 longer, thick, serrated. Setae S_1 and S_2 present. Ventrianal shield longer than wide (Fig. 276), rectangular, with anterior margin straight, lateral margins slightly convex, and with four pairs pre-anal setae and a pair of pores. Legs without macrosetae. Collected only in Florida. Type locality: "*Callicarpa americana*", Coral Gables, Florida.

***T. (T.) herbertae* sp.n. (Figs. 46, 47)**

Typhlodromus conspicuus var. *herbertae* Nesbitt, 1951: 22-23.

The specimens used by Nesbitt to describe his variety have been examined and I consider that they represent a valid species, distinct from *T.* (*T.*) *conspicuus*. Nesbitt clearly indicated his intention to describe this as in an infrasubspecific entity and I am introducing the name he used at the specific level for the first time. Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 46). All setae smooth, anterior laterals only slightly longer than distances between their bases. Ventrianal shield with four pairs of pre-anal setae (Fig. 47). Three pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Legs without macrosetae.

Locality and Type Material.—The holotype and five other females, collected by Dr. Nesbitt from apple leaves, Aldershot, Nova Scotia, in July, 1950, are in the Canadian National Collection (No. 5965). The species appears to be fairly common on deciduous fruit trees in Eastern Canada.

T. validus Group

Dorsally this group resembles the *pomi* group; dorsal shield with 17 pairs of setae, nine in the lateral rows, and arranged with only L_8 and L_9 on the posterior third of the shield. However, the ventrianal shield has only three pairs of pre-anal setae.

Key to Species of *validus* Group

1. Seta M_2 nearly as long as distance between its base and that of seta L_8 (Fig. 48) ..... *T.* (*T.*) *validus* Chant

   Seta M_2 much shorter than distance between its base and that of seta L_8 (Fig. 50) ..... *T.* (*T.*) *nelsoni* sp.n.

***T. (T.) validus* Chant (Figs. 48, 49)**

Typhlodromus validus Chant, 1957a: 290; Figs. 3-5.

Holotype in Canadian National Collection (No. 6538).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 48). All setae moderately long. Ventrianal shield with three pairs of pre-anal setae (Fig. 49). Two pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Six pairs of minute sclerotized plates on membrane between ventrianal shield and metapodal plates. In some specimens there is a sclerotized posterior projection of the sternal shield that extends almost to the vulva. Collected in British Columbia and California. Type locality: ponderosa pine, McIntyre Creek, British Columbia.

***T. (T.) nelsoni* sp.n. (Figs. 50, 51)**

Female.—Length 356 μ; width 189 μ. Dorsal shield reticulated, with 17 pairs of setae arranged as in *T. (T.) validus* (Fig. 50). Setae L_1 to L_5 less than half as long as the distances between their bases. Seta M_2 not more than half as long as distance between its base and that of L_8. Seta L_9 short (27 μ).

Ventral surface as in *T. (T.) validus* (Fig. 51) except there are only three pairs of minute sclerotized plates between ventrianal shield and metapodal plates, whereas in *T. (T.) validus* there are six pairs.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of position of specimen. Legs normal, without specialized setae.

Male.—Unknown.

Diagnosis.—All setae on dorsal shield shorter than in *T. (T.) validus* and there are fewer small sclerotized plates on the posterior ventral membrane.

Locality and Type Material.—The holotype and three other females, collected at Camp Nelson, California, July 23, 1947, from cedar, by Dr. E. W. Baker, are in the United States National Museum.

T. pomi Group

Dorsal shield with nine pairs of lateral setae arranged with L_1 to L_7 on the anterior two-thirds of the shield and with only L_8 and L_9 on the posterior third. Thus, there is a distinct gap between setae L_7 and L_8. Ventrianal shield with four pairs of pre-anal setae.

Key to Species of *pomi* Group

1. Three pairs of setae on membrane surrounding ventrianal shield ..... *T. (T.) pomi* (Parrott)
   Two pairs of setae on membrane surrounding ventrianal shield 2
2. Lateral setae L_1 to L_6 almost equal to, or slightly longer than distances between their bases (Fig. 54) ..... ***T. (T.) mcgregori* sp.n.**
   Lateral setae L_1 to L_6 shorter than distances between their bases (Fig. 56) ..... *T. (T.) flumenis* Chant

***T. (T.) pomi* (Parrott) (Figs. 52, 53)**

Seius pomi Parrott, 1906: 302; Plate IV, Fig. 3.
Iphidulus pomi (Parrott), Garman, 1948: 13; Fig. 3.
Typhlodromus pomi (Parrott), Nesbitt, 1951: 28-29; Figs. 7, 16.
Typhlodromus pomi (Parrott), Cunliffe and Baker, 1953: 20; figures.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 52). Ventrianal shield rectangular, with four pairs of pre-anal setae (Fig. 53). Three pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Legs without macrosetae. Common in Canada and the United States. Type locality: unspecified, probably apple, Geneva, New York.

Garman stated in his redescription of this species that the original type specimens were destroyed or lost and Nesbitt subsequently confirmed this opinion. Neither author remedied this situation by selecting a neotype. I have selected a specimen for this purpose that closely agrees with Garman's redescription. The species is common on many deciduous trees in Southeastern Ontario.

Locality and Type Material.—The neotype, collected on apple bark at the Belleville field station, Chatterton, Ontario, in March, 1958, is in the Canadian National Collection (No. 6858). This locality is about 250 miles from what is probably the original type locality.

***T. (T.) mcgregori* sp.n. (Figs. 54, 55)**

Typhlodromus new species, Cunliffe and Baker, 1953: 21; figures. (Type locality not specified.)

Non *Typhlodromus pacificus* McGregor, 1957: 8-9; Plate II, Figs. 8, 9.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 54). Lateral setae relatively long. Ventrianal shield rectangular, narrow, much longer than wide, with four pairs of pre-anal setae (Fig. 55). Only two pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. A pair of minute sclerotized plates between ventrianal shield and metapodal plates. Leg IV with one macroseta. Cunliffe and Baker (1953) gave an adequate description of this species but did not name it because it was to be described in greater detail by Dr. H. H. J. Nesbitt. McGregor (1957) intended to name it *T. pacificus* but his specimens were misidentified and he fixed as type a specimen of *T. (T.) pini* Chant. He used Cunliffe and Baker's illustrations for his paper. Therefore Cunliffe and Baker's species is still without a name and *T. mcgregori* is proposed in honour of Mr. E. A. McGregor. Collected in Mexico, the United States, and Canada. Found mostly in the West but also in Washington, D.C., Maryland, Virginia, and Ohio.

Locality and Type Material.—The holotype female, collected on arborvitae at Pasco, Washington, in May, 1953, by Mr. E. C. Klostermeyer, is in the Canadian National Collection (No. 6853).

***T. (T.) flumenis* Chant (Figs. 56, 57)**

Typhlodromus flumenis Chant, 1957a: 290, 292; Figs. 6, 7.

Holotype in Canadian National Collection (No. 6539).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 56). Lateral setae relatively short. Ventrianal shield rectangular, much longer than wide, with four pairs of pre-anal setae (Fig. 57). Only two pairs of setae on membrane surrounding ventrianal shield. Leg IV with one macroseta. Two pairs of metapodal plates. Three pairs of minute sclerotized plates between ventrianal shield and metapodal plates. Collected only in British Columbia. Type locality: soopolallie, nr. Hedley, Similkameen River, British Columbia.

T. occidentalis Group

Dorsal shield with nine pairs of lateral setae evenly spaced along margin of shield, and with long, narrow ventrianal shield with four pairs of pre-anal setae. All known forms have the setae on dorsal shield very long, longer than distances between their bases.

Key to Species of *occidentalis* Group

1. Seta M_1 short in relation to other setae on dorsal shield (Fig. 60) 2
   Seta M_1 not noticeably shorter than setae D_1 to D_5 (Fig. 62) 3

2. Setae L_2 and L_3 short (Fig. 60) ..... *T.* (*T.*) *gratus* sp.n.
Setae L_2 and L_3 not shorter than other lateral setae (Fig. 58) .... *T.* (*T.*) ***helveolus*** **nom. n.**
3. Dorsal setae longer than distances between their bases; peritreme long ..... *T.* (*T.*) *longipilis* Nesbitt
Dorsal setae slightly shorter than, or equal to, distances between their bases; peritreme short ..... *T.* (*T.*) *occidentalis* Nesbitt

T. (T.) *helveolus* nom. n. (Figs. 58, 59)

Typhlodromus floridanus Muma, 1955b: 269-270; Figs. 19, 20.

Holotype in United States National Museum, Washington, D.C.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 58). Seta M_1 short, remaining setae very long and longer than distances between their bases. Ventrianal shield much longer than wide, with lateral margins slightly constricted, posterior margin rounded, with four pairs of pre-anal setae (Fig. 59). Three pairs of setae on membrane surrounding ventrianal shield. One pair, long, narrow, metapodal plates. Legs without macrosetae. This species was adequately described by Muma (1955) except that he did not mention the shortness of seta M_1, which is the most striking feature separating this species from the others of its group. The species became a homonym of *Amblyseiopsis floridanus* Muma when the genus *Amblyseiopsis* was combined with *Typhlodromus* (Chant, 1957b). Because *A. floridanus* has page priority I have chosen to reject *T. floridanus* as a junior homonym. The name *helveolus* was proposed to me by Muma (*in litt.*) for this species. Collected in Florida and Texas. Type locality: citrus seedlings, Lake Alfred, Florida.

T. (T.) *gratus* sp.n. (Figs. 60, 61)

Female.—Length 327 μ; width 163 μ. Dorsal shield strongly reticulated, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 60). Lateral setae long, measurements as follows: L_1 41 μ; L_2 36 μ; L_3 38 μ; L_4 48 μ; L_5 61 μ; L_6 68 μ; L_7 72 μ; L_8 59 μ; L_9 65 μ. Setae L_2 and L_3 shorter than remainder. Seta M_2 long (70 μ); seta M_1 shortest on shield (23 μ). Dorsal setae long, except D_6. A faint pore slightly anterior to base of M_2. Bases of setae M_2 and L_8 closer to each other than to bases of any other setae. All setae smooth.

Seta S_1 on interscutal membrane; S_2 absent. Peritreme broad, with stout, hooked, truncate, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield reticulated, longer (108 μ) than wide (77 μ), with lateral margins constricted, posterior margin rounded, and with four pairs of pre-anal setae and a pair of pores (Fig. 61). Three pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (51 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with two teeth and pilus dentilis; movable digit without teeth. Legs normal, without specialized setae.

Male.—Unknown.

Diagnosis.—Distinguished from similar species by the lengths of setae L_1, L_2, L_3, and M_1 on the dorsal shield.

Locality and Type Material.—The holotype, another female, and a deutonymph, collected from "*Thespesia populnea*" at Key West, Florida, June 4, 1953, by Mr. O. D. Link, are in the United States National Museum.

***T. (T.) longipilis* Nesbitt (Figs. 62, 63)**

Typhlodromus longipilis Nesbitt, 1951: 26-27; Figs. 8, 21, 24.
Typhlodromus longipilis Nesbitt, Cunliffe and Baker, 1953: 17; figures.
Holotype in Canadian National Collection (No. 5967).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 62). Except D_1 and D_6 all setae extremely long. Remaining dorsal setae longer than distances between their bases. Ventrianal shield much longer than wide, slightly reticulated, with four pairs of pre-anal setae (Fig. 63). Three pairs of setae on membrane surrounding ventrianal shield. Legs without macrosetae. Not always easily separated from *T.* (*T.*) *occidentalis* despite apparent differences in the length of the dorsal setae. A reliable difference is shown in the length of the peritremes of the two species; in *T.* (*T.*) *occidentalis* the peritreme is very short whereas in *T.* (*T.*) *longipilis* it is much longer. Collected in many parts of Canada and the United States, most common in the West. Type locality: apple leaves, Central Experimental Farm, Ottawa, Canada.

***T. (T.) occidentalis* Nesbitt (Figs. 64, 65)**

Typhlodromus occidentalis Nesbitt, 1951: 29-30.
Typhlodromus occidentalis Nesbitt, Cunliffe and Baker, 1953: 18; figures.
Typhlodromus occidentalis Nesbitt, Chant, 1958: 630-633; fig. 15.
Typhlodromus occidentalis Nesbitt, Kennett, 1958: 474.
Holotype in Canadian National Collection (No. 5968).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 64). Except D_1 and D_6 all setae long. Dorsal setae equal to or slightly longer than distances between their bases, but not as long as in *T.* (*T.*) *longipilis*. Peritreme very short. Ventrianal shield much longer than wide, slightly reticulated, with four pairs of pre-anal setae (Fig. 65). Three pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Legs without macrosetae. Nesbitt's original description records that this species has only three pairs of pre-anal setae but this was taken from an aberrant specimen and four pairs of pre-anal setae is the usual number. Collected from many parts of Canada and the United States, most common in the West. There are unconfirmed reports that this species also occurs in Europe. Type locality: rose, Brandon, Manitoba.

***T. soleiger* Group**

Dorsal shield with 19 pairs of setae, 10 in the lateral rows and three in the median rows (Fig. 66). Ventrianal shield sole-shaped, much longer than wide, with only two pairs of pre-anal setae (Fig. 67). This group contains only one species.

***T. (T.) soleiger* (Ribaga) (Figs. 66, 67)**

Seiulus soleiger Ribaga, 1902: 176.
Typhlodromus soleiger (Ribaga), Nesbitt, 1951: 39-40; Figs. 30, 32.
Typhlodromus soleiger (Ribaga), Chant, 1956: 26.
Typhlodromus soleiger (Ribaga), Collyer, 1956: 206-208.
Typhlodromus soleiger (Ribaga), Chant, 1958: 618, 622; Figs. 11, 21, 25.

Nesbitt stated that the whereabouts of the holotype of this species is unknown. Dr. A. E. Pritchard (*in litt.*) informs me that Ribaga's collection is still present in Italy, possibly in Portici, and until this has been examined it is impossible to class the type as lost and to designate a neotype.

This species is characterized by the description of the group. It differs from all others of the genus by having three pairs of median setae. Collected in Europe, England, Canada, and the United States. Type locality: citrus leaves, Portici, Italy.

T. barkeri Group

Dorsal shield with 18 pairs of setae, 10 in the lateral rows. Ventrianal shield with three pairs of pre-anal setae.

Key to Species of *barkeri* Group

1. Setae L_2 to L_9 shorter than distances between their bases (Fig. 76) 2
   Most of setae L_2 to L_9 equal to or longer than distances between their bases (Fig. 70) 4
2. Setae L_1 and M_2 long (Fig. 76) ..... *T. (T.) juniperus* sp.n.
   Setae L_1 and M_2 short (Fig. 74) 3
3. Ventrianal shield much longer than wide; lateral margins of ventrianal shield constricted (Fig. 75) ..... *T. (T.) singularis* Chant
   Ventrianal shield only slightly longer than wide; lateral margins of ventrianal shield convex (Fig. 73) ..... *T. (T.) barkeri* (Hughes)
4. Five pairs of setae on membrane surrounding ventrianal shield (Fig. 71) ..... *T. (T.) invectus* sp.n.
   Four pairs of setae on membrane surrounding ventrianal shield (Fig. 69) 5
5. Setae L_2 and L_9 minute (Fig. 305); leg IV with three macrosetae ..... *T. (T.) hartlandrowei* Evans
   Seta L_2 slightly if any shorter than other lateral setae, L_9 minute (Fig. 68); legs without macrosetae ..... *T. (T.) transvaalensis* (Nesbitt)

T. (T.) transvaalensis (Nesbitt) (Figs. 68, 69)

Kampimodromus transvaalensis Nesbitt, 1951: 55-56.
Typhlodromus transvaalensis (Nesbitt), Chant, 1955: 498.

Holotype in the Canadian National Collection (No. 5970).

Dorsal shield with 18 pairs of slightly serrated, slender setae, 10 in the lateral rows (Fig. 68). Most lateral setae longer than distances between their bases. Seta L_9 minute. Ventrianal shield triangular, longer than wide, with three pairs of pre-anal setae (Fig. 69). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Legs without macrosetae. Nesbitt recorded this species from peanuts in South Africa and on rats in Florida, and I have specimens collected from *Stanhopea* sp. leaves from the Panama Canal Zone. Nesbitt did not figure this species but he kindly made available to me the holotype female, and the present description and drawings were made from this. Type locality: ground peanuts, Nylstroom, Transvaal, Union of South Africa.

T. (T.) hartlandrowei Evans (Figs. 305, 306)

Typhlodromus (T.) hartlandrowei Evans, 1959: 580-581; Figs. 1-3.

Holotype in British Museum (Natural History), London.

Dorsal shield with 18 pairs of slender setae, 10 in the lateral rows (Fig. 305). Most lateral setae much longer than distances between their bases (longer than in *T. (T.) transvaalensis*). Setae L_2, L_9, D_6 minute. Ventrianal shield (Fig. 306) nearly triangular, about as long as wide, with three pairs of pre-anal setae. One pair of metapodal plates. Leg IV with three macrosetae, genu, tibia, basitarsus. Four pairs of setae on membrane surrounding ventrianal shield. Known only from the type locality: nest of social spiders, Uganda.

T. (T.) invectus sp.n. (Figs. 70, 71)

Female.—Length 338 μ; width 163 μ. Dorsal shield faintly reticulated, with 18 pairs of setae, 10 in the lateral, two in the median, and six in the dorsal rows (Fig. 70). Setae L_{10} and M_2 the longest on shield (72 and 42 μ respectively), but all setae fairly long. Setae L_{10} and M_2 serrated, remaining setae smooth. Setae L_8 and L_9 shorter than remaining lateral setae. Bases of setae L_8, L_9, and M_2 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme slender, with slender posterior projection curving around base of coxa IV. Sternal shield normal,

with three pairs of setae. Metasternal plates large, close to sternal shield, with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (90 μ) than wide (72 μ), with lateral margins markedly constricted, with posterior margin rounded, and with three pairs of pre-anal setae (Fig. 71). Five pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (48 μ), the remainder short. One pair of long, slender metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, without specialized setae.

Male.—Unknown.

Diagnosis.—Separated from the other species of the group by the relative shortness of the setae on the dorsal shield (seta L_8 particularly) and by the presence of five pairs of setae on the membrane surrounding the ventrianal shield.

Locality and Type Material.—The holotype and a deutonymph collected on loquat from Sidon, Lebanon, imported at Philadelphia, U.S.A., April 27, 1953, are in the United States National Museum.

T. (T.) barkeri (Hughes) (Figs. 72, 73)

Neoseiulus barkeri Hughes, 1948: 141-143; Figs. 200-206.
Typhlodromus barkeri (Hughes), Nesbitt, 1951: 35-36; Figs. 31, 33.
Holotype in British Museum (Natural History) (?)

Dorsal shield with 18 pairs of smooth setae, 10 in the lateral rows (Fig. 72). All setae short. Ventrianal shield only slightly longer than wide, with lateral margins convex, and with three pairs of pre-anal setae (Fig. 73). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Recorded only from stored food products. Nesbitt suggested that this species and *T. polonicus* (Willmann) are the same but Evans (*in litt.*) and I agree that Willmann's drawings are probably incorrect and that his species has only nine pairs of lateral setae on the dorsal shield. This matter cannot be resolved until Willmann's types have been examined. Type locality: germinating barley plumules, London Docks, London, England.

T. (T.) singularis Chant (Figs. 74, 75)

Typhlodromus singularis Chant, 1957a: 289, 290; Figs. 1, 2.
Holotype in Canadian National Collection (No. 6537).

Dorsal shield with 18 pairs of setae, 10 in the lateral rows (Fig. 74). One pair of pores associated with seta L_5, another with L_3. Ventrianal shield much longer than wide, with lateral margins constricted, and with three pairs of pre-anal setae (Fig. 75). Three pairs of setae on membrane surrounding ventrianal shield. One pair of long, narrow metapodal plates. Legs normal, without macrosetae. Collected only in British Columbia, Oregon, and North Dakota. Type locality: Douglas fir, McIntyre Creek, British Columbia.

T. (T.) juniperus sp.n. (Figs. 76, 77)

Female.—Length 302 μ; width 208 μ. Dorsal shield reticulated, and having 18 pairs of setae, 10 in the lateral, two in the median, and six in the dorsal rows (Fig. 76). All setae short or minute, L_9 the longest (59 μ). Setae L_2, L_3, L_8, and L_9 minute and approximately equal in length. Five pairs of pores on dorsal shield, associated with setae L_4, L_5, L_6, L_9, and M_2. Bases of setae L_8, L_9 and M_2 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with slender, lobed, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, with a fourth pair

of setae. Genital shield normal. Ventrianal shield marked by lateral folds, longer (104 μ) than wide (72 μ), with anterior and posterior margins convex, lateral margins constricted, and with three pairs of pre-anal setae (Fig. 77). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (45 μ), the remainder short. Two pairs of long, slender, metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, with three short, stout, macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the relative lengths of the lateral setae on the dorsal shield, and by the shape and character of the ventrianal shield.

Locality and Type Material.—One female, collected on juniper imported from Japan at Seattle, Washington, U.S.A., June 23, 1952, is in the United States National Museum.

T. rhenanus Group

Dorsal shield with nine or 10 pairs of lateral setae evenly spaced along margin. Ventrianal shield triangular, with four pairs of pre-anal setae. In *T.* (*T.*) *pyri* with only nine pairs of lateral setae, the penultimate pair is absent and its position marked by a pair of distinct pores; however, the arrangement of the remaining setae and the character of the ventrianal shield show this species to be closely related to *T.* (*T.*) *rhenanus*.

Key to Species of *rhenanus* Group

1. Ten pairs of lateral setae on dorsal shield 2
   Nine pairs of lateral setae on dorsal shield ..... *T.* (*T.*) *pyri* Scheuten
2. Dorsum heavily sclerotized in mature adults; ventrianal shield creased (Fig. 81); without macrosetae on leg IV ..... *T.* (*T.*) *bakeri* (Garman)
   Dorsum weakly sclerotized in mature adults; ventrianal shield smooth (Fig. 79); with or without macrosetae on leg IV 3
3. Without macrosetae on leg IV ..... *T.* (*T.*) *caudiglans* Schuster
   With macrosetae on leg IV 4
4. With macrosetae on leg IV spatulate distally ..... *T.* (*T.*) *vulgaris* Ehara
   With macrosetae on leg IV tapering to distal point 5
5. Macrosetae on leg IV shorter (Fig. 277); males with five pairs pre-anal setae (Fig. 278) ..... *T.* (*T.*) *recki* Wainstein
   Macrosetae on leg IV longer (Fig. 279); males with four pairs pre-anal setae (Fig. 279) ..... *T.* (*T.*) *rhenanus* (Oudemans)

T. (T.) recki Wainstein (Figs. 277, 278)

Typhlodromus recki Wainstein, 1958: 203-205; Figs. 8, 9, 10.
T. (*T.*) *georgicus* Wainstein, 1958: 205; Figs. 11, 12, 13. ***New synonymy.*** (Type locality: mimosa (?), Georgia, U.S.S.R.)
Holotype probably in Wainstein's collection, U.S.S.R.

This species very closely resembles *T. rhenanus* but apparently differs from it by the males having five (Fig. 278), instead of four, pairs of pre-anal setae, and by having the macrosetae on leg IV short (Fig. 277). It differs from *T. bakeri* by having a smooth ventrianal shield and by being less sclerotized and reticulated. Collected on woody plants in Georgia, U.S.S.R. Type locality: "*Salvia nemorosa*", Georgia, U.S.S.R.

I feel that the differences between *T.* (*T.*) *georgicus* and *T.* (*T.*) *recki*, as shown in the author's descriptions, do not justify separation at the specific level. Provisionally I consider the two as synonymous.

T. (T.) rhenanus (Oudemans) (Figs. 78, 79, 279, 280)

Seiulus rhenanus Oudemans, 1905: lxxviii.

Seiulus rhenanus Oudemans, Oudemans, 1915b: 154-156.
Typhlodromus foenilis Oudemans, 1930: 70.
Typhlodromus rhenanus (Oudemans), Nesbitt, 1951: 38-39; Figs. 13, 20, 27, Plates XIV, XV.
Typhlodromus rhenanus (Oudemans), Cunliffe and Baker, 1953: 9; figures.
Typhlodromus rhenanus (Oudemans), Chant, 1956: 26.
Typhlodromus rhenanus (Oudemans), Collyer, 1956: 206-208.
Typhlodromus rhenanus (Oudemans), Chant, 1958: 615-618; Figs. 9, 19, 25.
Typhlodromus kazachstanicus Wainstein, 1958: 203; Figs. 1-7. *New synonymy*. (Type locality: apple (?), Georgia, U.S.S.R.)

Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 18 pairs of setae, 10 in the lateral rows (Fig. 78). Ventrianal shield triangular, with four pairs of pre-anal setae, and occasionally a pair of pores (Fig. 79). Four setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. In some specimens two or three pairs of minute sclerotized plates lying between ventrianal shield and metapodal plates. Leg IV usually with one macroseta (Fig. 279). Male ventrianal shield as in Fig. 280. In some specimens, particularly females collected during winter, L_9, L_{10}, and M_2 serrated and the dorsum heavily sclerotized; however, even in these the degree of sclerotization and imbrication is less than in *T.* (*T.*) *bakeri*. Chant (1958) showed this species to be most easily separated from *T.* (*T.*) *bakeri* in the larval stage. Collected in Europe, England, Canada, and the United States. Prefers woody trees and shrubs to herbs and grasses. Type locality: rotting leaves, Benel near Bonn, Germany.

T. kazachstanicus does not appear to differ from *T. rhenanus* and I consider them synonymous. Wainstein mentioned a number of differences but these seem to be based on a misunderstanding of *T. rhenanus*. He stated "according to dorsal shield, close to *T. rhenanus* from which it [*T. kazachstanicus*] differs by lacking a pre-anal pore, in the form of the macrosetae on leg IV, in the placement of the sternal setae, and in the shape of the spermatodactyl [on the male chelicera]". In fact, Wainstein's description indicates that *kazachstanicus* does not differ from *rhenanus* in most of these features. Intra-specific variation accounts for the few small differences that seem to be evident. Wainstein's specimens were collected on various trees in Georgia, U.S.S.R.

T. (T.) bakeri (Garman) (Figs. 80, 81)

Seiulus bakeri Garman, 1948: 15; Fig. 7.
Typhlodromus bakeri (Garman), Nesbitt, 1951: 36-37; Figs. 28, 29.
Typhlodromus bakeri (Garman), Cunliffe and Baker, 1953: 10; figures.
Typhlodromus bakeri (Garman), Womersley, 1954: 183; Fig. 8.
Typhlodromus bakeri (Garman), Chant, 1956: 31-32; Fig. 7.
Typhlodromus bakeri (Garman), Chant, 1958: 605, 608; Figs. 2, 3, 4, 19, 25.

Holotype in Connecticut Agricultural Experiment Station collection, New Haven.

Dorsal shield heavily sclerotized, reticulated, and with 18 pairs of setae, 10 in the lateral rows (Fig. 80). Some lateral setae on small tubercles. Setae L_{10} and M_2 serrated. Ventrianal shield triangular, with anterior margin convex, and with four pairs of pre-anal setae (Fig. 81). Ventrianal shield usually showing a number of concentric creases around anus; Nesbitt (1951) considered these to be sutures that indicated the presence of secondary sclerotized plates but I feel that they are formed when the uniquely convex ventrianal shield is compressed between the cover slip and the slide in a microscopic preparation. Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Legs without macrosetae. Collected in England, Europe, Canada, the United States, Australia, and New Zealand. Almost entirely bark inhabiting. Type locality: apple bark, Hamden, Connecticut.

T. (T.) pyri Scheuten (Figs. 82, 83)

Typhlodromus pyri Scheuten, 1857: 104-112.
Typhlodromus tiliae Oudemans, 1929: 14-15, 33, 51. *New synonymy.* (Type locality: *Tilia* sp., Arnhem, The Netherlands.)
Typhlodromus pyri Scheuten, Oudemans, 1930: 97-101.
Typhlodromus pyri Scheuten, Vitzthum, 1941: 767.
Typhlodromus pyri Scheuten, Nesbitt, 1951: 5-8.
Typhlodromus tiliae Oudemans, Nesbitt, 1951: 18-20; Figs. 1, 3, 15, 25, Plates IV, V.
Typhlodromus tiliae Oudemans, Cunliffe and Baker, 1953: 12; figures.
Typhlodromus tiliae Oudemans, Chant, 1956: 26.
Typhlodromus tiliae Oudemans, Collyer, 1956: 206-207.
Typhlodromus tiliae Oudemans, Chant, 1958: 608, 611; Figs. 5, 19, 25.

Nesbitt stated "that *Typhlodromus pyri* Sch., 1857, and *T. tiliae* Oudms., 1929 are very closely related if not identical, and that the specimens of *T. tiliae* in the Oudemans collection in the Rijksmuseum van Natuurlijke Historie, Leiden, bearing the labels 'op *Tilia platyphylles* Arnhem 1900' could be regarded as *Typhlodromus pyri* and considered illustrative of the genus *Typhlodromus*." Curiously, Nesbitt let matters rest with this statement and in the remainder of his paper did not treat *tiliae* as a synonym of *pyri*. Nesbitt's lucid arguments convinced me that these two names refer to the same species and they are herein considered as synonymous.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 82). Penultimate pair of lateral setae absent, its position marked by a pair of distinct pores. Ventrianal shield triangular, longer than wide, with four pairs of pre-anal setae (Fig. 83). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with one macroseta. Collected in England, Europe, Canada, and the United States. Type locality: pear leaves, Bonn, Germany.

Scheuten's specimens have been lost and a neotype should be designated. I have not done this because I have no specimens from pear leaves in Europe.

T. (T.) *caudiglans* Schuster

Typhlodromus (T.) caudiglans Schuster, 1959: 88-90; Figs. 1-7.
Holotype in California Academy of Sciences.
Paratype in Canadian National Collection (No. 6860).

This species closely resembles *T. (T.) rhenanus* except that leg IV is without macrosetae. The neck of the coxal gland is narrow, as in *T. (T.) bakeri;* in *T. (T.) rhenanus* the neck is broad. The lateral setae of *caudiglans* are not on small tubercles. Collected only in California. Type locality: Davis, Yolo Co., California.

T. (T.) *vulgaris* Ehara

Typhlodromus vulgaris Ehara, 1959: 286-288; Figs. 1-5.
Holotype in Zoological Institute, Faculty of Science, Hokkaido University, Japan.

In all respects but the shape of the macrosetae on leg IV *T. (T.) vulgaris* closely resembles *T. (T.) rhenanus.* In the former the three macrosetae on leg IV are spatulate whereas in *T. (T.) rhenanus* the single macroseta tapers to a point. Common on apple leaves in Japan. Type locality: apple leaves, Sapporo, Hokkaido, Japan.

***T. tiliarum* Group**

Dorsal shield with 11 pairs of lateral setae. Ventrianal shield with three or four pairs of pre-anal setae.

Key to Species of *tiliarum* Group

1. Three pairs of pre-anal setae on ventrianal shield (Fig. 89) ..... *T. (T.) nesbitti* Womersley
   Four pairs of pre-anal setae on ventrianal shield (Fig. 85) 2
2. Three pairs of distinct pores on dorsal shield (Fig. 84); setae L_{11} and M_2 not serrated ..... *T. (T.) tiliarum* Oudemans
   Without pores on dorsal shield (Fig. 86); setae L_{11} and M_2 serrated ..... *T. (T.) aceri* Collyer

***T. (T.) tiliarum* Oudemans (Figs. 84, 85)**

Typhlodromus tiliarum Oudemans, 1930: 51-52.
Typhlodromus tiliarum Oudemans, Nesbitt, 1951: 31; Plate VI.
Typhlodromus tiliarum Oudemans, Chant, 1955: 600-601; Fig. 3.
Typhlodromus tiliarum Oudemans, Chant, 1956: 26.
Typhlodromus tiliarum Oudemans, Collyer, 1956: 206-208.
Typhlodromus tiliarum Oudemans, Chant, 1958: 622; Figs. 12, 21, 25.
Typhlodromus formosus Wainstein, 1958: 206-207. *New synonymy*. (Type locality: elm, Georgia, U.S.S.R.)

Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 19 pairs of setae, 11 in the lateral rows (Fig. 84). Three pairs of distinct pores on dorsal shield, one associated with seta L_{10}, one between setae L_6 and D_4, and one between setae L_4 and D_2. Sternal shield with only two pairs of setae; two pairs of metasternal plates, each with a pair of setae. Ventrianal shield much longer than wide, oblong, with four pairs of pre-anal setae (Fig. 85). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Legs without macrosetae. Collected in Eastern Canada, England, and Europe. Type locality: *Tilia* sp., Dahlem, Germany.

Wainstein's description indicates that *T. formosus* is very similar to *T. tiliarum*. He presented no figures and did not compare the two. Provisionally, I consider them synonymous.

***T. (T.) aceri* Collyer (Figs. 86, 87)**

Typhlodromus aceri Collyer, 1957: 199; Fig. 1.
Typhlodromus aceri Collyer, Chant, 1958: 626; Figs. 14, 23, 26.
Typhlodromus tuberculatus Wainstein, 1958: 205-206. *New synonymy*. (Type locality: *Acer* sp., Georgia, U.S.S.R.)

Holotype in British Museum (Natural History).

Dorsal shield with 19 pairs of setae, 11 in the lateral rows (Fig. 86). Without pores. Setae L_{11} and M_2 serrated. Sternal shield with only two pairs of setae; two pairs of metasternal plates, each with a pair of setae. Ventrianal shield only slightly longer than wide, with posterior margin rounded, and with four pairs of pre-anal setae (Fig. 87). Four pairs of setae on membrane surrounding ventrianal shield. One pair of long metapodal plates. Two pairs of minute sclerotized plates lying on membrane between ventrianal shield and metapodal plates. Legs without macrosetae. Collected in England, Russia, and the United States, found only on trees of the genus *Acer*. Type locality: *Acer* sp., Stondon Massey, Essex, England.

Wainstein's description, even to host-plant specificity, indicates that *T. tuberculatus* is very close to *T. aceri*. Provisionally, I consider them synonymous.

***T. (T.) nesbitti* Womersley (Figs. 88, 89)**

Typhlodromus nesbitti Womersley, 1954: 179-180; Fig. 5.

Holotype on loan to Canadian National Collection.

Dorsal shield with 19 pairs of setae, 11 in the lateral rows (Fig. 88), and without distinct pores. Sternal shield with three pairs of setae; one pair of metasternal plates, each with a seta. Ventrianal shield longer than wide, with posterior margin rounded, and with three pairs of pre-anal setae (Fig. 89). Four

pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with one macroseta. Known from a single specimen collected in Australia. Type locality: galls on tree lucerne, Goulburn, N.S.W., Australia.

T. australicus Group

Dorsal shield with 20 pairs of setae, 12 in the lateral rows. Ventrianal shield with four pairs of pre-anal setae. There is only one known species.

T. (T.) australicus (Womersley) (Figs. 90, 91)

Kampimodromus australicus Womersley, 1954: 185-187; Fig. 10.
Typhlodromus australicus (Womersley), Chant, 1955: 498.

Holotype on loan to Canadian National Collection.

Dorsal shield with 20 pairs of short, serrated setae, 12 in the lateral rows (Fig. 90). Seta M_2 paired with L_{10}. Ventrianal shield triangular, much longer than wide, with lateral margins straight, and with four pairs of pre-anal setae (Fig. 91). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Womersley's drawings indicate that there is one pair of minute sclerotized plates on membrane between genital and ventrianal shields. Legs without specialized setae. Known from a single specimen collected in Australia. Type locality: under lecanium scale on "*Eunonymus*", Bathurst, N.S.W., Australia.

Subgenus *Amblyseius* Berlese

Type by original designation: *Zercon obtusus* Koch.

Key to Species Groups of Subgenus *Amblyseius*

1. Eighteen pairs of setae on dorsal shield ..... *sextus* group
   Seventeen or less pairs of setae on dorsal shield 2
2. Pre-anal setae arranged almost in transverse row across anterior third of ventrianal shield (Fig. 95); ventrianal shield almost oval in outline ..... *finlandicus* group
   Pre-anal setae not arranged in transverse row across anterior third of ventrianal shield (Figs. 117, 221); ventrianal shield not usually oval in outline 3
3. Ventrianal shield with one pair of pre-anal setae ..... *setosus* group
   Ventrianal shield with more than one pair of pre-anal setae 4
4. Ventrianal shield with two pairs of pre-anal setae ..... *irregularis* group
   Ventrianal shield with three pairs of pre-anal setae 5
5. Nine pairs of lateral setae on dorsal shield 6
   Less than nine pairs of lateral setae on dorsal shield 7
6. Ventrianal shield approximately triangular or squarish in outline; frequently scarcely longer than wide ..... *obtusus* group
   Ventrianal shield vase shaped (Fig. 221), much longer than wide, with widest part of shield at or near anus ..... *newsami* group
7. All lateral setae on dorsal shield of approximately equal length (Fig. 240); ventrianal shield much longer than broad, oblong ..... *aberrans* group
   Some lateral setae on dorsal shield much longer than others (Fig. 246); ventrianal shield triangular or as broad as long 8
8. Setae L_7 and L_8 absent, and seven pairs of lateral setae on dorsal shield (Fig. 244) ..... *grandis* group
   Seta L_8 present, and with seven or eight pairs of lateral setae on dorsal shield (Figs. 246, 247) ..... *sandersi* group

T. sextus Group

Dorsal shield with 18 pairs of setae, nine in the lateral rows, three in the median rows. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores. There is only one known species.

T. (A.) sextus (Garman) comb. n. (Figs. 92, 93)

Amblyseiopsis sexta Garman, 1958: 72-73; Fig. 4.

Holotype in United States National Museum.

Dorsal shield with 18 pairs of setae, nine in the lateral and three in the median rows (Fig. 92). Setae M_2, M_3, and L_{10} serrated. Ventrianal shield triangular, longer than wide, with lateral margins constricted, and with three pairs of pre-anal setae and a pair of pores (Fig. 93). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Leg IV with two macrosetae. Collected on various plants in Texas. Type locality: roses, Brownsville, Texas.

T. finlandicus Group

Dorsal shield with 17 pairs of setae, nine in the lateral rows. Ventrianal shield usually nearly oval in outline, with margins rounded, convex, and with three pairs of pre-anal setae arranged in transverse row across anterior third of shield (Fig. 95), and only one pair of pre-anal setae on margin of shield.

Key to Species of *finlandicus* Group

1. All setae on dorsal shield minute, except L_9 and D_1 which are long ... *T.* (*A.*) *ovalis* Evans
   Some lateral setae on dorsal shield in addition to L_9 long ... 2
2. Seta L_6 longer than L_5 (Fig. 100); peritreme long ... *T.* (*A.*) *hibisci* sp.n.
   Setae L_5 and L_6 approximately equal in length; peritreme long or short. ... 3
3. Seta L_2 much shorter than L_3 (Fig. 98) ... 4
   Seta L_2 not, or scarcely, shorter than L_3 (Fig. 94) ... 6
4. Lateral setae on dorsal shield generally short, except L_9 (Fig. 106) ... *T.* (*A.*) *mesembrinus* Dean
   Some lateral setae on dorsal shield much longer than others (Fig. 102) ... 5
5. Lateral margins of ventrianal shield constricted but approximately parallel (Fig. 103); ventrianal shield not or scarcely, broader at posterior end ... *T.* (*A.*) *aferulus* sp.n.
   Lateral margins of ventrianal shield constricted but diverging posteriorly (Fig. 105); ventrianal shield wider posteriorly ... *T.* (*A.*) *concordis* sp.n.
6. Seta L_1 much longer than L_2 (Fig. 98); peritreme long ... *T.* (*A.*) *victoriensis* Womersley
   Seta L_1 only slightly longer than L_2 (Fig. 94); peritreme short ... *T.* (*A.*) *finlandicus* (Oudemans)

T. (*A.*) *finlandicus* (Oudemans) (Figs. 94, 95)

Seiulus finlandicus Oudemans, 1915a: 183.
Seiulus finlandicus Oudemans, Oudemans, 1915b: 159-161.
Typhlodromus pruni Oudemans, 1929: 32-33.
Typhlodromus finlandicus (Oudemans), Oudemans, 1929: 50.
Typhlodromus finlandicus (Oudemans), Nesbitt, 1951: 25-26; Figs. 5, 12, 19, Plate III.
Typhlodromus finlandicus (Oudemans), Cunliffe and Baker, 1953: 19; figures.
Typhlodromus finlandicus (Oudemans), Womersley, 1954: 182.
Typhlodromus finlandicus (Oudemans), Chant, 1956: 26.
Typhlodromus finlandicus (Oudemans), Collyer, 1956: 206-208.
Typhlodromus finlandicus (Oudemans), Ehara, 1958: 53-55; Figs. 1-3.
Amblyseius finlandicus (Oudemans), Athias-Henriot, 1958: 34, 36.
Typhlodromus finlandicus (Oudemans), Chant, 1958: 611-612; Figs. 6, 20, 25.
Typhlodromus finlandicus (Oudemans), Ehara, 1958: 53-55; Figs. 1-3.
Amblyseius finlandicus (Oudemans), Ehara, 1959: 285.

Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 94). Setae L_1 to L_3 approximately equal in length. Setae L_5 and L_6 equal in length. Lateral setae generally short, but not minute. Seta L_9 longest on shield, sometimes serrated. Peritreme not extending beyond coxa II; in all others of this group, peritreme extends at least to coxa I. Ventrianal shield approximately oval, with three pairs of pre-anal setae arranged in transverse row across anterior third of shield, and with a pair of distinct pores (Fig. 95). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Europe, England, Canada, and the United States. Type locality: "*Salix caprea*", Åbo, Finland.

***T. (A.) ovalis* Evans (Figs. 96, 97)**

Typhlodromus ovalis Evans, 1953: 458-461; Figs. 5, 6.
Typhlodromus ovalis Evans, Womersley, 1954: 182.
Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 96). Setae D_1 and L_9 long; remaining setae short or minute. Ventrianal shield oval, with three pairs of pre-anal setae arranged in transverse row across anterior third of shield, and with a pair of pores (Fig. 97). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Hawaii, Mauritius, Mexico, and Malaya. Type locality: rubber, Kuala Lumpur, Malaya.

***T. (A.) victoriensis* Womersley (Figs. 98, 99)**

Typhlodromus victoriensis Womersley, 1954: 180-182; Fig. 6.
Holotype in South Australia Museum, Adelaide.
Paratype on loan to Canadian National Collection.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 98). Setae L_2 and L_3, L_5 and L_6 short and equal in length. Setae D_1 and L_1 much longer than L_2; seta L_4 longer than L_3. Seta L_9 long, thickened, and slightly serrated. Ventrianal shield approximately oval, with three pairs of pre-anal setae arranged in a nearly transverse row across anterior third of shield, with a pair of pores (Fig. 99). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Known from two specimens collected in Australia. Type locality: citrus leaf, Burnley, Victoria, Australia.

***T. (A.) hibisci* sp.n. (Figs. 100, 101)**

Female.—Length 325 μ; width 190 μ. Dorsal shield smooth and with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 100). Setae L_1, L_4, and L_9 moderately long (49, 54, and 68 μ respectively). Seta L_2 (27 μ) slightly shorter than L_3 (36 μ). Seta L_5 (14 μ) less than half as long as L_6 (32 μ). Setae L_7 and L_8 approximately equal in length (36 μ) and longer than M_2 (18 μ). Bases of setae L_8, L_7, and M_2 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme narrow, with short slender, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (99 μ) than wide (68 μ), oval, with lateral margins convex and widest part at anus, with three pairs of pre-anal setae arranged on the anterior third of shield, and with a pair of pores (Fig. 101). One pair of metapodal plates. Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (41 μ), the remainder minute.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of position of specimens. Legs normal, with three long macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—The ventral surface of this species is similar to that of *T. finlandicus* and the others of this group. However, the chaetotaxy of the dorsal shield is distinctive.

Locality and Type Material.—The holotype, a female, and a deutonymph, collected on *Hibiscus* sp. leaves at Alamos, Sonora, Mexico, March 6, 1951, by Mr. Crow, are in the United States National Museum. Common on citrus and avocado in California, Mexico, and Guatemala.

***T. (A.) aferulus* sp.n. (Figs. 102, 103)**

Female.—Length 352 μ; width 185 μ. Dorsal shield faintly reticulated, and having 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 102). Setae D_1, L_1, L_4, and L_9 moderately long (36, 36, 63, and 50 μ respectively). Remaining setae short or minute. Seta L_3 twice length of L_2. Setae L_5 and L_6 equal in length. Bases of setae M_2 and L_7 closer to each other than to that of L_8.

Seta S_2 on interscutal membrane; S_1 absent. Peritreme narrow, with slender, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, oval, and with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (104 μ) than wide (59 μ), with anterior and posterior margins rounded and with lateral margins concave, with three pairs of pre-anal setae on anterior third of shield, and with a pair of pores (Fig. 103). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (36 μ), the remainder short. One pair of slender metapodal plates present.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs with setae generally shorter and stouter than normal for the genus, leg IV with three stout and very long macrosetae (49 μ).

Male.—Ventrianal shield with three pairs of setae in addition to para-anals, and a pair of pores. Chelicera with spermatophoral process.

Diagnosis.—Distinguished by the relative lengths of the lateral setae on the dorsal shield, and by the shape of the ventrianal shield of the female.

Locality and Type Material.—The holotype, another female, and one male, collected from citrus at Crocodile Valley Citrus Estates, Nelspruit, East Transvaal, South Africa, in February, 1953, are in the United States National Museum.

***T. (A.) concordis* sp.n. (Figs. 104, 105)**

Female.—Length 316 μ; width 176 μ. Dorsal shield smooth, and having 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 104). Setae D_1 L_1, L_3, L_4, and L_9 moderately long (23, 32, 27, 41, and 59 μ respectively). Seta M_2 minute. Setae L_5 and L_6 short and approximately equal in length. Remaining setae short or minute. Seta L_2 half as long as L_3. Bases of setae L_7, L_8, and M_2 forming a triangle with approximately equal sides.

Seta S_1 on interscutal membrane; S_2 absent. Peritreme broad with slender posterior projection curving sharply around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (104 μ) than wide (50 μ), vase shaped with anterior end broad, with lateral margins straight and divergent posteriorly, with posterior margin rounded, with three pairs of pre-anal setae arranged on anterior third of shield, and with a pair of distinct pores (Fig. 105). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (27 μ), the remainder short. One pair of long, slender, metapodal plates present.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the chaetotaxy of the dorsal shield and by the shape of the ventrianal shield.

Locality and Type Material.—A single female specimen collected on citrus at Concordia, Entre Rios, Argentina, December, 1948, by Mr. King, is in the

United States National Museum. Dr. E. W. Baker collected more specimens in Central America in 1959.

***T. (A.) mesembrinus* Dean (Figs. 106, 107)**

Typhlodromus mesembrinus Dean, 1957: 165.

Holotype in United States National Museum (No. 2224).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 106). Setae L_9 and D_1 moderately long, remaining setae short or minute. Seta L_1 approximately as long as L_3. Setae L_5 and L_6 equal to one another. Ventrianal shield oval but much longer than wide, with three pairs of pre-anal setae, and with a pair of pores (Fig. 107). Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected in Texas and Mexico on ash leaves (*Fraxinus* sp.) and citrus. Type locality: corn leaves, Mercedes, Texas. Dean did not illustrate his description.

***T. setosus* Group**

Dorsal shield with 16 pairs of setae, eight in the lateral rows. Ventrianal shield with one pair of pre-anal setae. There is only one known species.

***T. (A.) setosus* (Muma) comb. n. (Figs. 108, 109)**

Amblyseiella setosa Muma, 1955b: 266-268; Figs. 13, 14.
Phytoseiulus setosa (Muma), Garman, 1958: 70.

Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 108). Seta L_8 absent. Setae L_1, L_3, L_4, L_6, L_9, and M_2 long. Seta L_3 twice as long as L_2. Seta L_5 minute. Ventrianal shield almost square, as wide as long, with one pair of pre-anal setae (Fig. 109). Six pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected only in Florida. Type locality: scaly orange leaves, Tampa, Florida.

***T. irregularis* Group**

Dorsal shield with 16 or 17 pairs of setae, eight or nine in the lateral rows. If with eight pairs of lateral setae, L_7 absent (Fig. 110). Ventrianal shield with two pairs of pre-anal setae.

Key to Species of *irregularis* Group

1. Nine pairs of lateral setae on dorsal shield ..... *T. (A.) italicus* sp.n.
   Eight pairs of lateral setae on dorsal shield ..... *T. (A.) irregularis* Evans

***T. (A.) irregularis* Evans (Figs. 110, 111)**

Typhlodromus irregularis Evans, 1953: 463-466; Fig. 9.

Holotype in British Museum (Natural History).

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 110). All setae short. Seta L_7 absent. Ventrianal shield oval, with two pairs of pre-anal setae and a pair of pores (Fig. 111). Five pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Known from three females collected in Malaya. Type locality: "leaves, Malaya".

***T. (A.) italicus* sp.n. (Figs. 112, 113)**

Female.—Length 419 μ; width 230 μ. Dorsal shield smooth, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 112). Setae L_1, L_4, L_9, and M_2 long (59, 122, 253, and 113 μ respectively). Seta L_2 (23 μ) shorter than L_3 (44 μ). Setae L_5, L_6, L_7, and L_8 minute, of equal length.

Remaining setae minute except D_1. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with slender, truncate, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates oval, with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (144 μ) than wide (68 μ), with anterior margin almost straight, lateral margins constricted, and posterior margin rounded, with two pairs of pre-anal setae and a pair of pores (Fig. 113). Five pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long (72 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Separated from all other species by having nine pairs of lateral setae on dorsal shield and only two pairs of pre-anal setae on ventrianal shield.

Locality and Type Material.—The holotype and three other females (one of which is aberrant and has only four setae on the membrane surrounding the ventrianal shield on one side), collected on beach leaves imported from Italy at New York City on September 12, 1950, by Messrs. Hidalgo and Corlis, are in the United States National Museum.

T. obtusus Group

Dorsal shield with 17 pairs of setae, nine in the lateral rows. Ventrianal shield triangular, or squarish, or rectangular, with three pairs of pre-anal setae. The group is classified on the lengths of all setae on the dorsal shield, the relative lengths of setae L_2 and L_3, and L_5 and L_6, and on characters of the ventrianal shield and its surrounding membrane.

Key to Species of the *obtusus* Group

1. All setae on dorsal shield except D_1, D_6, and L_8 very long (Fig. 114) ..... *T. (A.) longispinosus* Evans
   Some setae on dorsal shield besides D_1, D_6, and L_8 short or minute (Figs. 138, 162) 2
2. All setae on dorsal shield short or minute, none greatly longer than others (Fig. 116) 3
   Some setae on dorsal shield (eg. L_1, L_4, L_9, or M_2) much longer than others (Fig. 190) 18
3. Setae of dorsal hexagonal area (i.e. D_2, D_3, D_4, and M_1) longer than distances between their bases ..... *T. (A.) fallacis* (Garman)
   Setae of dorsal hexagonal area shorter than distances between their bases 4
4. Setae L_1 to L_4 longer than or equal to distances between their bases (Fig. 118) 5
   Setae L_1 to L_4 much shorter than distances between their bases (Fig. 136) 8
5. Setae L_1 to L_4 much longer than distances between their bases (Fig. 118) ..... *T. (A.) masseei* Nesbitt
   Setae L_1 to L_4 approximately equal to distances between their bases (Fig. 122) 6
6. Seta L_9 serrated, shorter than M_2 ..... *T. (A.) ornatus* Athias-Henriot
   Seta L_9 smooth, longer than M_2 7
7. Seta L_9 nearly twice as long as M_2; one macroseta on leg IV ..... *T. (A.) bellinus* Womersley
   Seta L_9 not more than 1.4 times as long as M_2; three macrosetae on leg IV ..... *T. (A.) umbraticus* Chant
8. Ventrianal shield long and narrow; four pairs of small sclerotized plates in addition to metapodals on membrane surrounding ventrianal shield (Fig. 125) ..... *T. (A.) desertus* Chant
   Ventrianal shield triangular; not more than three pairs of small sclerotized plates in addition to metapodals on membrane surrounding ventrianal shield (Figs. 127, 128) 9

9. Ventrianal shield as wide as, or wider than, long; lateral margins of shield rounded (Fig. 127) 10
Ventrianal shield longer than wide, lateral margins concave or parallel (Fig. 131) 12
10. Setae L_7 and L_8 approximately equal in length 11
Seta L_7 noticeably longer than L_8 ..... *T.* (*A.*) *scoticus* Collyer
11. Seta M_2 much shorter than distance between its base and that of L_9 (Fig. 128) ..... *T.* (*A.*) *reticulatus* Oudemans
Seta M_2 longer than distance between its base and that of L_9 (Fig. 132) ..... *T.* (*A.*) *novaescotiae* sp.n.
12. Setae L_2 and L_3 much shorter than L_1 and L_4 (Fig. 130) ..... *T.* (*A.*) *amicus* sp.n.
Setae L_1 to L_4 approximately equal in length (Fig. 136) 13
13. Setae L_1 to L_4 approximately one half as long as distances between their bases (Fig. 136) 14
Setae L_1 to L_4 less than half as long as distances between their bases (Fig. 138) 15
14. Fixed digit of chelicera with two teeth and pilus dentilis; movable digit without teeth; ventrianal shield triangular (Fig. 137) ..... *T.* (*A.*) *cucumeris* Oudemans
Fixed digit of chelicera with three teeth and pilus dentilis; movable digit with one tooth; ventrianal shield rectangular (Fig. 288) ..... *T.* (*A.*) *brevispinus* Kennett
15. A large species, length averaging greater than 440 μ ..... *T.* (*A.*) *zwoelferi* Dosse
Smaller species, length averaging less than 400 μ 16
16. Ventrianal shield nearly square, anterior margin straight, lateral margins straight and parallel (Fig. 292) ..... *T.* (*A.*) *paspalivorus* De Leon
Ventrianal shield triangular, anterior corners rounded 17
17. Seta L_9 with thickened base; setae L_7, L_8, L_9, M_2 serrated; sternal shield deeply excavated posteriorly ..... *T.* (*A.*) *longilaterus* Athias-Henriot
Seta L_9 without thickened base; setae L_7, L_8, L_9, M_2 smooth; posterior margin of sternal shield straight, or nearly so ..... *T.* (*A.*) *marinus* Willmann
18. Setae L_1 to L_4 short and approximately equal; only seta L_9, or M_2 and L_9, noticeably longer than other setae on dorsal shield (Figs. 140, 293) 19
Setae L_1 to L_4 unequal in length, not all short; setae M_2 and L_9 not the only long setae on dorsal shield (Figs. 142, 144) 20
19. Seta M_2 long (Fig. 140) ..... *T.* (*A.*) *asiaticus* Evans
Seta M_2 short (Fig. 293) ..... *T.* (*A.*) *japonicus* Ehara
20. Setae L_2 and L_3 approximately equal in length (Fig. 142) 21
Setae L_2 and L_3 not equal in length (Fig. 188) 43
21. Setae L_5 and L_6 approximately equal in length (Fig. 142) 22
Setae L_5 and L_6 not equal in length (Fig. 176) 38
22. Seta L_1 approximately equal to D_1 23
Seta L_1 noticeably longer than D_1 25
23. Seta D_5 absent ..... *T.* (*A.*) *asetus* sp.n.
Seta D_5 present 24
24. Seta M_2 long (Fig. 114) ..... *T.* (*A.*) *callunae* (Willmann) comb. n.
Seta M_2 short (Fig. 146) ..... *T.* (*A.*) *garmani* nom. n.
25. Seta D_5 absent 26
Seta D_5 present 28
26. Seta M_2 as long as, or longer than, L_9 (Fig. 148) ..... *T.* (*A.*) *rosellus* sp.n.
Seta M_2 shorter than L_9 (Fig. 150) 27
27. Setae L_4, L_9, and M_2 short (Fig. 150) ..... *T.* (*A.*) *lepidus* sp.n.
Setae L_4, L_9, and M_2 long (Fig. 154) ..... *T.* (*A.*) *guatemalensis* nom. n.
28. Setae L_2 and L_3 minute (Fig. 158) 30
Setae L_2 and L_3 longer (Fig. 156) 29
29. Setae L_5 and L_6 minute (Fig. 152) ..... *T.* (*A.*) *aequipilis* (Berlese)
Setae L_5 and L_6 longer (Fig. 156) ..... *T.* (*A.*) *fraterculus* (Berlese)
30. Ventrianal shield much longer than wide (Fig. 159) 31
Ventrianal shield scarcely longer, or shorter, than wide (Fig. 166) 34
31. Three pairs of setae on membrane surrounding ventrianal shield ..... *T.* (*A.*) *krantzi* nom. n.
Four pairs of setae on membrane surrounding ventrianal shield 32

32. All setae on dorsal shield except D_1, L_1, L_4, L_9, and M_2 extremely small, some apparently represented only by a pore (Fig. 160) ..... *T. (A.) multidentatus* sp.n.
All setae on dorsal shield except D_1, L_1, L_4, L_9, and M_2 minute but not as small as above (Fig. 162) 33
33. Ventrianal shield as in Fig. 163 ..... *T. (A.) perlongisetus* (Berlese)
Ventrianal shield as in Fig. 164 ..... *T. (A.) herbicolus* sp.n.
34. Two pairs of slender, elongate, sclerotized plates on membrane between ventrianal shield and genital shield (Fig. 166) 35
Without sclerotized plates on membrane between ventrianal and genital shields 36
35. Ventrianal shield very reticulated (Fig. 166); metapodal plates elongate, slender ..... *T. (A.) morgani* Chant
Ventrianal shield slightly reticulated (Fig. 302); larger metapodal plate broadly triangular ..... *T. (A.) meridionalis* (Berlese)
36. Lateral margins of ventrianal shield approximately parallel for most of length, then converging posteriorly (Fig. 168) ..... *T. (A.) floridanus* (Muma) comb. n.
Lateral margins of ventrianal shield converging gently through entire length (Fig. 170) 37
37. Metapodal plates slender; posterior margin of ventrianal shield rounded (Fig. 170) ..... *T. (A.) longulus* (Berlese)
Metapodal plates oval; posterior margin of ventrianal shield pointed (Fig. 172) ..... *T. (A.) caudatus* (Berlese)
38. Seta L_1 approximately equal in length to L_2 (Fig. 174) 39
Seta L_1 much longer than L_2 (Fig. 184) 40
39. Seta D_5 absent ..... *T. (A.) lichenis* sp.n.
Seta D_5 present ..... *T. (A.) collyerae* sp.n.
40. Setae L_4, L_9, and M_2 long (Fig. 178) 41
Setae L_4, L_9, and M_2 short (Fig. 184) ..... *T. (A.) graminis* (Chant) comb. n.
41. Seta L_9 serrated; ventrianal shield longer than wide, with lateral margins scarcely indented (Fig. 179) ..... *T. (A.) britannicus* sp.n.
Seta L_9 not serrated; ventrianal shield as above, or almost as wide as long, with lateral margins indented (Fig. 183) 42
42. Ventrianal shield longer than wide, with lateral margins scarcely indented (Fig. 181) ..... *T. (A.) aerialis* (Muma) comb. n.
Ventrianal shield almost as wide as long, with lateral margins markedly indented (Fig. 183) ..... *T. (A.) schusteri* sp.n.
43. Seta L_2 noticeably longer than L_3 44
Seta L_3 noticeably longer than L_2 54
44. Seta L_6 longer than L_5 45
Setae L_5 and L_6 equal in length 48
45. Seta L_6 almost as long as M_2 (Fig. 186) ..... *T. (A.) neomexicanus* nom. n.
Seta L_6 noticeably shorter than M_2 (Fig. 188) 46
46. Seta L_1 longer than D_1; setae L_9 and M_2 smooth 47
Seta L_1 equal to D_1; setae L_9 and M_2 serrated ..... *T. (A.) rademacheri* (Dosse) comb. n.
47. Ventrianal shield broad, with slight waist; genital shield broad; heavily sclerotized; setae slender; sternal shield reticulated; L_1 and L_2 longer (Fig. 188) ..... *T. (A.) fragariae* (Kennett) comb. n.
Ventrianal shield narrower (Fig. 300) with more pronounced waist; genital shield narrow, lightly sclerotized; setae robust; sternal shield smooth; L_1 and L_2 shorter (Fig. 299) ..... *T. (A.) exopodalis* (Kennett) comb. n.
48. Seta D_5 present 49
Seta D_5 absent 50
49. Metapodal plates elongate; lateral margins of ventrianal shield straight, converging posteriorly (Fig. 191) ..... *T. (A.) foenalis* (Berlese)
Metapodal plates rectangular; lateral margins of ventrianal shield convex, converging posteriorly (Fig. 193) ..... *T. (A.) obtusus* (Berlese)
50. Seta L_2 nearly equal in length to L_1 (Fig. 194) ..... *T. (A.) ovatus* (Garman) comb. n.
Seta L_2 noticeably shorter than L_1 (Fig. 196) 51
51. A pair of pores on dorsal shield in position usually occupied by seta D_5 ..... *T. (A.) oregonensis* (Garman) comb. n.
Without a pair of pores on dorsal shield in position usually occupied by seta D_5 52

52. Junction of lateral and anterior margins of ventrianal shield drawn to a peak directed laterally; lateral margins of shield convex and curving gently to a point behind anus (Fig. 199) ..... *T. (A.) putmani* sp.n.
Ventrianal shield not as above 53
53. Ventrianal shield with marked lateral constriction (Fig. 201) ..... *T. (A.) tropicanus* (Garman) comb. n.
Ventrianal shield without marked lateral constriction (Fig. 203) ..... *T. (A.) mexicanus* (Garman) comb. n.
54. Seta L_5 noticeably shorter than L_6 55
Setae L_5 and L_6 approximately equal in length 59
55. Seta D_5 present 56
Seta D_5 absent 58
56. Seta L_2 less than half as long as L_3; seta L_9 more than twice as long as M_2 57
Seta L_2 more than half as long as L_3; seta L_9 less than twice as long as M_2 ..... *T. (A.) similis* (Koch)
57. With basitarsal macroseta on leg IV much longer than those on genu and tibia ..... *T. (A.) tsugawai* (Ehara) comb. n.
With basitarsal macroseta on leg IV only slightly longer than those on genu and tibia ..... *T. (A.) andersoni* Chant
58. Seta L_6 long (Fig. 206) ..... *T. (A.) septus* (Garman) comb. n.
Seta L_6 short (Fig. 208) ..... *T. (A.) okanagensis* Chant
59. Lateral margins of ventrianal shield constricted (Fig. 211) ..... *T. (A.) potentillae* (Garman) comb. n.
Lateral margins of ventrianal shield not markedly constricted (Figs. 213, 215) 60
60. Ventrianal shield of same width as genital shield (Fig. 215) ..... *T. (A.) americanus* (Garman) comb. n.
Ventrianal shield wider than genital shield (Figs. 217, 219) 61
61. Ventrianal shield without pores; seta L_2 short but not minute, and only slightly shorter than L_3 (Fig. 216); setae on membrane surrounding ventrianal shield not lying close to shield (Fig. 217) ..... *T. (A.) silvaticus* sp.n.
Ventrianal shield with one pair of pores; seta L_2 minute, less than half as long as L_3 (Fig. 218); setae on membrane surrounding ventrianal shield lying very close to shield (Fig. 219) ..... *T. (A.) gracilis* (Garman) comb. n.

T. (A.) longispinosus Evans (Figs. 114, 115)

Typhlodromus longispinosus Evans, 1952a: 413-416; Figs. 1, 2.
Typhlodromus longispinosus Evans, Womersley, 1954: 177; Fig. 3.
Typhlodromus longispinosus Evans, Ehara, 1958: 55-56; Figs. 4-6.
Amblyseius longispinosus (Evans), Ehara, 1959: 228.

Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 114). All setae long or very long, except D_1, D_6, and L_8. Seta L_9 four times as long as L_8. Ventrianal shield triangular, longer than wide, with three pairs of pre-anal setae and a pair of pores (Fig. 115). Four pairs of sete on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with one macroseta. Collected in Indonesia, South America, and Tasmania. Type locality: "*Manihot untillisima*", Indonesia.

T. (A.) fallacis (Garman) (Figs. 116, 117)

Iphidulus fallacis Garman, 1948: 13; Fig. 5.
Typhlodromus fallacis (Garman) Nesbitt, 1951: 24-25; Figs. 2, 4, 11, 17.
Typhlodromus fallacis (Garman), Cunliffe and Baker, 1953: 13; figures.
Typhlodromus fallacis (Garman), Womersley, 1954: 174; Fig. 1.
Typhlodromus fallacis (Garman), Ballard, 1954: 175-179.
Amblyseius fallacis (Garman), Athias-Henriot, 1958: 34.

Holotype in Connecticut Agricultural Experiment Station collection, New Haven.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 116). Setae of dorsal hexagonal area longer than distances between their bases. Ventrianal shield triangular, longer than wide, with three pairs of pre-anal setae and a pair

of pores (Fig. 117). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Leg IV with one macroseta. Collected in Canada, the United States, and Australia. Type habitat: apple leaves, Branford, Connecticut.

T. (A.) masseei Nesbitt (Figs. 118, 119)

Typhlodromus masseei Nesbitt, 1951: 27-28; Text Fig. 1, Figs. 10, 14, 23, 26.
Typhlodromus masseei Nesbitt, Chant, 1956: 26.
Typhlodromus masseei Nesbitt, Collyer, 1956: 204-206.
Typhlodromus masseei Nesbitt, Chant, 1958: 622, 623, 626; Figs. 13, 22, 25.
Holotype in Canadian National Collection (No. 5966).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 118). Setae of dorsal hexagonal area shorter than distances between their bases. Seta L_2 shorter than L_3. Seta L_5 shorter than L_6. Ventrianal shield triangular, longer than wide, and with three pairs of pre-anal setae and a pair of pores (Fig. 119). Four pairs of setae on membrane surrounding ventrianal shield. One pair of large metapodal plates. Leg IV with three macrosetae. Collected in England and Canada. Type habitat: apple leaves and twigs, Berwick, Nova Scotia.

T. (A.) ornatus Athias-Henriot (Figs. 295, 296)

Typhlodromus ornatus Athias-Henriot, 1957b: 216-218; Fig. 2.
Typhlodromus chilensis Dosse, 1958a: 5-59; Figs. 11-15. *New synonymy.*
Typhlodromus chilensis Dosse, Dosse, 1958b: 3-4; Fig. 4.
Holotype in Muséum National d'Histoire Naturelle, Paris, France.

Dorsal shield smooth, with 17 pairs of setae, nine in lateral rows (Fig. 295). Setae L_1 to L_4 longer than distances between their bases. Setae of dorsal hexagonal area shorter than distances between their bases. Setae L_9, M_2 slightly serrated, L_9 shorter than M_2. Setae S_1 and S_2 present. Sternal shield with three pairs of setae, fourth pair on metasternal plates. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 296). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Two pairs of platelets between genital and ventrianal shields, one long, slender, the other oblong. Seven minute areas of sclerotization around genital and ventrianal shields. Legs without macrosetae. Collected in Algeria and Chile. Type locality: *Rubus* sp. leaves, Bareki, Algeria.

T. (A.) bellinus Womersley (Figs. 120, 121)

Typhlodromus bellinus Womersley, 1954: 177-179; Fig. 4.
Typhlodromus bellinus Womersley, Chant, 1956: 26.
Typhlodromus bellinus Womersley, Kennett, 1958: 472-473.
Amblyseius bellinus (Womersley), Athias-Henriot, 1959: 147-148; Fig. 4.
Holotype on loan to Canadian National Collection.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 120). Setae of dorsal hexagonal area shorter than distances between their bases. Setae L_1 to L_4 approximately equal to distances between their bases. Seta L_9 nearly twice as long as M_2. Ventrianal shield triangular, longer than wide, and with three pairs of pre-anal setae and a pair of pores (Fig. 121). Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with one macroseta. Fixed digit of chelicera with two denticules and pilus dentilis; movable digit with one scarcely noticeable tooth. Known from two specimens collected in Australia. Type locality: strawberry plants, Burnley, Victoria, Australia.

T. (A.) umbraticus Chant (Figs. 122, 123)

Typhlodromus umbraticus Chant, 1956: 26-31; Figs. 1, 2.
Typhlodromus umbraticus Chant, Collyer, 1956: 206-208.

Typhlodromus umbraticus Chant, Chant, 1958: 612; Figs. 7, 20, 25.
Amblyseius umbraticus (Chant) Athias-Henriot, 1959: 144-145.
Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 122). Setae of dorsal hexagonal area shorter than distances between their bases. Setae L_1 to L_4 approximately equal to distances between their bases. Seta L_9 not more than 1.4 times as long as M_2. Ventrianal shield triangular, longer than wide, with three pairs of pre-anal setae and a pair of pores (Fig. 123). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Fixed digit of chelicera with five denticules and pilus dentilis; movable digit with two teeth. Collected in Switzerland, England, and the United States. Type locality: *Rubus* sp. leaves, East Malling, Kent, England.

T. (A.) desertus Chant (Figs. 124, 125)

Typhlodromus desertus Chant, 1957a: 294, 296; Figs. 15, 16.
Holotype in Canadian National Collection (No. 6544).

Dorsal shield reticulated and with 17 pairs of setae, nine in the lateral rows (Fig. 124). Setae L_1 to L_4 shorter than distances between their bases. Ventrianal shield very long and narrow, with three pairs of pre-anal setae (Fig. 125). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Four pairs of minute sclerotized plates on membrane between ventrianal shield and metapodal plates. Legs without macrosetae. Collected only in Western Canada. Type locality: black cottonwood, McIntyre Creek, British Columbia.

T. (A.) scoticus Collyer (Figs. 126, 127)

Typhlodromus scoticus Collyer, 1957: 200-202; Fig. 2.
Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 126). Setae L_1 to L_4 shorter than distances between their bases. Seta M_2 longer than distance between its base and that of L_9. Seta L_7 longer than L_8. Ventrianal shield triangular, scarcely longer than wide, with lateral margins rounded, with three pairs of pre-anal setae and a pair of pores (Fig. 127). Four pairs of setae on membrane surrounding ventrianal shield. One pair of long metapodal plates. Legs without macrosetae. Collected only in Scotland. Type locality: *Salix* sp. leaves, Kyle of Lochalsh, Scotland.

T. (A.) reticulatus Oudemans (Figs. 128, 129)

Typhlodromus reticulatus Oudemans, 1930: 70-71.
Typhlodromus reticulatus Oudemans, Nesbitt, 1951: 37-38; Plate XIII.
Typhlodromus reticulatus Oudemans, Womersley, 1954: 183; Fig. 7.
Typhlodromus reticulatus Oudemans, Huffaker and Kennett, 1953: 802.
Typhlodromus reticulatus Oudemans, Cunliffe and Baker, 1953: 16; figures.
Typhlodromus reticulatus Oudemans, Chant, 1955: 499-500; Fig. 2.
Typhlodromus reticulatus Oudemans, Chant, 1956: 26.
Typhlodromus reticulatus Oudemans, Chant, 1958: 618; Figs. 10, 21, 25.
Typhlodromus reticulatus Oudemans, Kennett, 1958: 472.
Amblyseius reticulatus (Oudemans) Athias-Henriot, 1959: 145.
Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield reticulated and with 17 pairs of setae, nine in the lateral rows (Fig. 128). Setae L_1 to L_4 much shorter than distances between their bases. All setae short. Seta M_2 much less than distance between its base and that of L_9. Setae L_7 and L_8 equal in length, short. Ventrianal shield as wide as long,

with lateral margins rounded, and with three pairs of pre-anal setae (Fig. 129). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with one macroseta. Collected in Europe, Canada, the United States, Australia, and abundant in southern England on broom (*Sarothamnus* sp.). Type locality: *Calluna vulgaris* L., Wageningen, The Netherlands.

***T. (A.) amicus* sp.n. (Figs. 130, 131)**

Female.—Length 388 μ; width 185 μ. Dorsal shield smooth and with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 130). Setal measurements as follows: L_1 27 μ; L_4 27 μ; L_5 14 μ; L_6 27 μ; L_7 32 μ; L_8 36 μ; L_9 72 μ; M_2 32 μ. Setae L_2 and L_3 short (14 μ) and equal in length. Seta L_5 shorter than L_6. Setae L_7, L_8, and L_9 slightly serrated. Bases of setae L_7 and M_2 closer to one another than to base of L_8. Three pairs of faint pores on dorsal shield.

Setae S_1 and S_2 on interscutal membrane. Peritreme with slender, slightly hooked, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates irregular in shape and with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (126 μ) than wide (108 μ), triangular, with three pairs of pre-anal setae (Fig. 131). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (49 μ), the remainder short. One pair of metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of position of specimen. Legs normal, with one macroseta on basitarsus of leg IV.

Male.—Unknown.

Diagnosis.—Separated from other species by the relative lengths of setae L_2, L_3, L_5, and L_6.

Locality and Type Material.—The holotype and a deutonymph, collected on citrus leaves at Bayview, Texas, May 25, 1951, by Dr. H. A. Dean, are in the United States National Museum.

***T. (A.) novaescotiae* sp.n. (Figs. 132, 133, 134, 135)**

Female.—Length 352 μ; width 230 μ. Dorsal shield heavily sclerotized, reticulated posteriorly, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 132). Setae L_1 to L_4 as long as, or slightly longer than, distances between their bases. Without any setae greatly longer than others.

Setae S_1 and S_2 on interscutal membrane. Sternal shield heavily sclerotized, reticulated, with three pairs of setae. One pair of metasternal plates, each with a seta. Genital shield broad, heavily sclerotized, reticulated, and with a pair of setae. Peritreme broad, with posterior extension curving around base of coxa IV (Fig. 133). Ventrianal shield heavily sclerotized, reticulated, as long as wide (122 μ), triangular with lateral margins rounded, and with three pairs of pre-anal setae and a pair of pores (Fig. 134). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one very long and narrow. Three pairs of small, sclerotized plates lying between ventrianal and genital shields, and coxa IV.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with five teeth and pilus dentilis; movable digit with two teeth. Legs short, stout, without macrosetae.

Male.—Ventrianal shield heavily sclerotized, reticulated, and with six pairs of pre-anal setae (Fig. 135). Chelicera with lobed spermatophore.

Diagnosis.—This species resembles *T.* (*A.*) ***bellinus*** and *T.* (*A.*) ***umbraticus*** most closely in its dorsal characters but it differs from these in the lengths of setae L_9 and M_2, and in the degree of sclerotization and ornamentation. It resembles *T.* (*A.*) ***reticulatus*** in its ventral characters but it differs from that species in the degree of sclerotization and by the presence of the small sclerotized plates in addition to the metapodal plates.

Locality and Type Material.—The holotype female and two males, collected at Coldbrook, Nova Scotia, September 21, 1949, by Dr. H. H. J. Nesbitt, from alder, are in the Canadian National Collection (No. 6854). Three females with similar collection data are in the Canadian National Collection at the Belleville laboratory.

T. (A.) cucumeris Oudemans (Figs. 136, 137)

Typhlodromus cucumeris Oudemans, 1930: 69-70.
Typhlodromus thripsi MacGill, 1939: 309-317; Figs. 1-15. (Type locality: cotton plants in greenhouse, Manchester, England.)
Typhlodromus cucumeris Oudemans, Nesbitt, 1951: 23; Figs. 6, 18, Plate II.
Typhlodromus cucumeris Oudemans, Evans, 1952a: 416.
Typhlodromus cucumeris Oudemans, Cunliffe and Baker, 1953: 15; figures.
Typhlodromus cucumeris Oudemans, Huffaker and Kennett, 1953: 802.
Typhlodromus cucumeris Oudemans, Womersley, 1954: 175-176; Fig. 2.
Typhlodromus cucumeris Oudemans, Chant, 1956: 26.
Typhlodromus cucumeris Oudemans, Collyer, 1956: 206-208.
Typhlodromus cucumeris Oudemans, Chant, 1958: 626, 630; Figs. 15, 22, 25.
Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 136). Setae L_1 to L_4 approximately half as long as distances between their bases. Setae of dorsal hexagonal area shorter than distances between their bases. Seta M_2 shorter than distance between its base and that of L_9. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 137). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. In some specimens a pair of minute, sclerotized plates lying on membrane between ventrianal and genital shields. Leg IV with one macroseta. Fixed digit of chelicera with two teeth and pilus dentilis; movable digit without teeth. Very common, collected in Switzerland, Germany, Holland, England, Canada, the United States, New Zealand, Mexico, Egypt, and Australia. Found mostly on low-growing annual plants, and in greenhouses. Type locality: "*Cucumis melo*", Buré, France.

T. (A.) brevispinus Kennett (Figs. 287, 288)

Typhlodromus brevispinus Kennett, 1958: 473; Figs. 1-5.
Holotype in United States National Museum.

Dorsal shield (Fig. 287) nearly identical with *T.* (*A.*) *cucumeris*. Ventrianal shield rectangular (Fig. 288), with three pairs of pre-anal setae. Four pairs of setae on membrane surrounding ventrianal shield. Two pairs metapodal plates. Leg IV with slender macroseta. Fixed digit of chelicera with three teeth and pilus dentilis; movable digit unidentate. Collected in California. Type locality: strawberry, Watsonville, California.

T. (A.) zwoelferi Dosse (Fig. 289)

Typhlodromus zwölferi [sic] Dosse, 1957: 301-311; Figs. 1-5.
Holotype in Institut für Pflanzenschutz der Landwirtschaftlichen Hochschule, Stuttgart-Hohenheim, Germany.

Dorsal shield with 17 pairs of setae, nine in lateral rows. All setae on dorsum short or minute, as in *T.* (*A.*) *marinus*. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores. Four pairs of setae on membrane surrounding ventrianal shield. A pair of small plates between genital and ventrianal shields. Length of dorsum greater than 440 μ.

Male ventrianal shield with five pairs of pre-anal setae (Fig. 289), one on, or slightly under, posterior lateral margin. Female appears to be identical with *T.* (*A.*) *marinus*, even to coxal gland or spermatheca, except for length. Placements of pre-anal setae in males, however, differ. Type locality: apple tree, Oldenburg, Germany.

T. (A.) paspalivorus De Leon (Figs. 291, 292)

Typhlodromus paspalivorus De Leon, 1957: 143-144; Figs. 8-10.
Holotype in De Leon's collection, Coral Gables, Florida.
Paratypes in University of Florida Collection, Gainesville.

Dorsal shield reticulated, with 17 pairs of setae (Fig. 291), nine in lateral rows. Seta L_0 serrated, 52 μ long. Remaining setae short or minute, smooth. Setae S_1 and S_2 present. Sternal shield with three pairs of setae, fourth pair on elongate metasternal plates. Ventrianal shield longer than wide (Fig. 292), rectangular, with anterior margin straight, lateral margins slightly convex, parallel, and with three pairs pre-anal setae and a pair of pores. Legs without macrosetae. Type locality: "*Paspalum*", Coral Gables, Florida.

T. (A.) longilaterus Athias-Henriot (Figs. 297, 298)

Typhlodromus longilaterus Athias-Henriot, 1957b: 218-221; Figs. 3A, B.
Holotype in Muséum National d'Histoire Naturelle, Paris, France.

Dorsal shield reticulated, with 17 pairs of setae (Fig. 298), nine in lateral rows. Setae L_1 to L_4 less than half distances between their bases. Setae of dorsal hexagonal area short. Setae L_7, L_8, L_9, M_2 slightly serrated. Seta L_9 swollen at base. Setae S_1 and S_2 present. Sternal shield deeply excavated posteriorly, with three pairs of setae, third pair on projections almost separated from rest of shield. Fourth pair on metasternal plates. Ventrianal shield triangular (Fig. 298), longer than wide, with three pairs pre-anal setae and a pair of pores. Four pairs of setae on membrane surrounding ventrianal shield, VL_1 serrated. Two pairs metapodal plates. A pair of small crescentic plates along anterior margin of ventrianal shield. Six minute areas of sclerotization on membrane around genital and ventrianal shields. Legs without macrosetae. Collected only in Algeria. Type locality: *Cyonodon dactylon* (L.) Pers., Rovigo, Algeria.

T. (A.) marinus (Willmann) (Figs. 138, 139, 290)

Lasioseius marinus Willmann, 1952: 146; 2 figs.
Typhlodromus marinus (Willmann), Chant, 1956: 26, 32.
Typhlodromus californicus McGregor, 1954: 89; Plate 21, Figs. 1-4. *New synonymy*. (Type locality: lemon, Whittier, California.)
Typhlodromus californicus McGregor, McGregor, 1956: 8.
Typhlodromus mungeri McGregor, 1954: 92; Plate 22, Figs. 1-6. *New synonymy*. (Type locality: lemon, Whittier, California.)
Typhlodromus (*Iphidulus*) *mungeri* McGregor, McGregor, 1956: 8.
Typhlodromus marinus (Willmann), Anderson, Morgan, and Chant, 1958: 277.
Typhlodromus marinus (Willmann), Chant, 1958: 630; Figs. 16, 22, 25.
Amblyseius mungeri (McGregor) Athias-Henriot, 1959: 145-146.
Holotype in Willmann's personal collection, Germany.

I examined McGregor's type specimens and found that *T. californicus*, described from a male, is synonymous with *T. mungeri*, described from a female.

The male is identical with the male of *T. marinus*. The females of *T. mungeri* and *T. marinus* differ only in the shape of the so-called "coxal glands" and these differences are slight and may be artifacts of mounting. Therefore *T. californicus* and *T. mungeri* are considered synonyms of *T. marinus*. Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 139). All setae very short and setae L_1 to L_4 less than half the distances between their bases. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 139). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with one macroseta. Male ventrianal shield (Fig. 290) with five pairs of pre-anal setae. Collected from seaweed along the North Sea, and along the Thames Estuary in England, on apple in West Virginia, on strawberries in Western Canada, on wheat, pine, mallow, citrus, alfalfa, and poplar leaves in the southwestern United States (Utah, Arizona, Texas, California, New Mexico) and on lemon fruit in Spanish Morocco. The ecologies of these diverse populations must be very dissimilar, but the populations are morphologically nearly identical. Type locality: salt marshes, North Sea, Germany.

T. (A.) asiaticus Evans (Figs. 140, 141)

Typhlodromus asiaticus Evans, 1953: 461-463; Figs. 7, 8.

Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 140). Setae L_9 and M_2 long and serrated, remaining setae short. Seta M_2 three quarters as long as L_9. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 141). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in Malaya and Indonesia. Type locality: Bogor, Indonesia.

T. (A.) japonicus Ehara (Figs. 293, 294)

Typhlodromus japonicus Ehara, 1958: 56-57; Figs. 7-9.
Amblyseius japonicus (Ehara) Ehara, 1959: 285.

Holotype in Ehara's collection (?), Hokkaido University, Japan.

Dorsal shield with 17 pairs of setae (Fig. 293), nine in lateral rows. All setae on dorsum minute except L_9, which is long, stout. Ventrianal shield triangular, longer than wide, with three pairs pre-anal setae and a pair of pores (Fig. 294). Leg IV with three macrosetae. Type locality: *Mallotus japonicus* Muell.-Arg., Koshino-o, Nishimera, Kyushu, Japan.

T. (A.) asetus sp.n. (Figs. 142, 143)

Female.–Length 336 μ; width 192 μ. Dorsal shield smooth, with 16 pairs of setae, nine in the lateral, two in the median, and five in the dorsal rows (Fig. 142). Seta D_5 absent. Setae L_1, L_4, L_9, and M_2 moderately or very long (25, 47, 110, and 65 μ respectively). Remaining setae minute, except D_1. Seta L_2 equal in length to L_3. Seta L_5 equal in length to L_6. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with short posterior projection curving slightly around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, with a fourth pair of setae. Genital shield normal. Ventrianal shield slightly reticulated, longer (110 μ) than wide (89 μ), triangular, and with three pairs of pre-anal setae (Fig. 143). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (61 μ), the remainder short. Two pairs of slender metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of positions of specimens. Legs normal, with macroseta on genu III, and three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Resembles *T.* (*A.*) *perlongisetus* but separated from it by the absence of seta D_5.

Locality and Type Material.—The holotype, collected at Kearneysville, West Virginia, July, 1953, by Dr. D. W. Clancy, on unsprayed apple leaves, is in the United States National Museum. A second female, collected at Weslaco, Texas, May 16, 1951, by Dr. H. A. Dean, from orange and grapefruit leaves, is in the Canadian National Collection at the Belleville laboratory.

T. (A.) callunae (Willmann) comb. n. (Figs. 144, 145)

Amblyseius callunae Willmann, 1952: 149; 2 figs.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 144). Setae L_2 and L_3, and L_5 and L_6 short, equal to one another. Setae L_1, L_4, L_9, and M_2 moderately long, or long. Willmann incorrectly placed setae S_1 and S_2 on the dorsal shield in his illustration. Ventrianal shield triangular, reticulated, and with three pairs of pre-anal setae (Fig. 145). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Two pairs of slender, elongate plates on membrane between ventrianal and genital shields. Leg IV with three macrosetae. Collected in Northern Germany and the Eastern United States. Type locality: *Calluna* sp., Northern Germany.

T. (A.) garmani nom. n. (Figs. 146, 147)

Amblyseiopsis limonicus Garman, 1958: 72; Fig. 3.
Non *Amblyseius limonicus* Garman and McGregor, 1956: 11-13; Plate 5, Figs. 1-6.
Holotype in United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 146). Setae L_1, L_4, and L_9 longer than others on the shield. Setae L_2, L_3, L_5, L_6, L_8 short, equal to one another. Seta L_7 almost as long as L_1. Seta M_2 very short. Seta L_9 slightly serrated. Ventrianal shield approximately triangular, with lateral margins almost parallel, with three pairs of pre-anal setae and a pair of pores (Fig. 147). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in California. Type locality: orange and lemon, Santa Ana, California. Garman omitted seta L_8 from his drawing. Garman's name for this species is a homonym of *T.* (*A.*) *limonicus* (Garman and McGregor, 1956) and the new name *garmani* is proposed.

T. (A.) rosellus sp.n. (Figs. 148, 149)

Female.—Length 311 μ; width 293 μ. Dorsal shield smooth, heavily sclerotized, and with 16 pairs of setae, nine in the lateral, two in the median, and five in the dorsal rows (Fig. 148). Seta D_5 absent, its position marked by a pore. Setae L_1, L_4, L_9, and M_2 long (59, 99, 90, and 113 μ respectively). Setae L_9 and M_2 strongly curled. Remaining lateral setae short. Setae L_2 and L_3, and L_5 and L_6 equal in length. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad, with lateral extensions between coxae II and III, and III and IV, and with a slender posterior projection curving slightly around base of coxa IV. Sternal shield heavily sclerotized, slightly reticulated, with three pairs of setae. Metasternal plates oval, with a fourth pair of setae. Genital shield heavily sclerotized, very

broad, with a pair of setae. Ventrianal shield reticulated, as wide as long (113 μ), triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 149). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long (81 μ), the remainder short. Two pairs of metapodal plates, one minute. Two pairs of elongate sclerotized plates between genital and ventrianal shields.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of position of specimens. Legs normal, with three long macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the relative lengths of the lateral setae on the dorsal shield and by the shape and character of the ventrianal shield.

Locality and Type Material.—The holotype female, collected at Tortola, British West Indies, October 11, 1955, by Mr. L. T. Sanders, from mountain rose vine, is in the United States National Museum.

T. (A.) lepidus sp.n. (Figs. 150, 151)

Female.—Length 333 μ; width 232 μ. Dorsal shield faintly reticulated, and having 16 pairs of setae, nine in the lateral, two in the median, and five in the dorsal rows (Fig. 152). Setae L_1, L_4, L_9, and M_2 moderately long (20, 45, 80, and 60 μ respectively), remaining setae minute, except D_1. Seta L_2 slightly longer than L_3. Setae L_5 and L_6 approximately equal in length. Seta D_5 absent and its position marked by a pore. Bases of setae L_7 and M_2 closer to one another than to that of L_8. Dorsal shield pitted with a variable number of minute pores.

Setae S_1 and S_2 minute, and on interscutal membrane. Peritreme with broad, truncate, posterior projection scarcely curving around base of coxa IV. Sternal shield reticulated, and with three pairs of setae. Metasternal plates oval and with a fourth pair of setae. Genital shield normal in shape, reticulated. Ventrianal shield almost square (108 μ long, 94 μ wide), with lateral margins parallel and anterior margin slightly concave, reticulated, and with three pairs of pre-anal setae and a pair of pores (Fig. 151). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (58 μ), the remainder short. Two pairs of long, slender metapodal plates, and between ventrianal shield and genital shields are three pairs of additional plates, two very long and slender, one small and oval. In all, five pairs of plates on posterior ventral surface.

Gnathosoma and maxillary palps typical of genus. Fixed digit of chelicera with pilus dentilis and five denticules; movable digit with one tooth. Legs normal and with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the relative lengths of setae L_2 and L_3, and L_5 and L_6, by the absence of seta D_5, and by characters of the posterior ventral surface.

Locality and Type Material.—The holotype, collected from strawberry at Baton Rouge, Louisiana, March 29, 1951, by Mr. J. S. Roussel, is in the United States National Museum. A second female, collected from apple at Churchland, Virginia, in July, 1953, is in the Canadian National Collection at the Belleville laboratory. A third specimen, collected on chickweed, Greenville Air Base, Missouri, February 28, 1955, by Mr. J. W. Dunnam, is also in the United States National Museum.

***T. (A.) aequipilus* (Berlese) (Figs. 152, 153)**

Amblyseius aequipilus Berlese, 1914: 145; Plate IV, Fig. 59.
Typhlodromus aequipilus (Berlese), Chant, 1957a: 302; Figs. 25, 26.

Holotype in Berlese Collection, Florence (No. 113/39).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 152). Setae L_4, L_9, and M_2 moderately long. Setae L_5 and L_6 minute. Setae L_1 and L_2 of equal length, approximately half as long as L_4, and slightly longer than L_3. Ventrianal shield oblong, longer than wide, and with three pairs of pre-anal setae (Fig. 153). Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected in Java and British Columbia. Type locality: "Java".

***T. (A.) guatemalensis* nom. n. (Figs. 154, 155)**

Amblyseiopsis elongatus Garman, 1958: 79; Fig. 17.
Amblyseius elongatus (Garman), Kennett, 1958: 476; Figs. 21-26.

Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 154). Seta D_5 absent. Setae L_2 and L_3, and L_5 and L_6 minute, equal in length. Setae L_1 (longer than D_1), L_4, L_9, and M_2 long. Seta M_2 much shorter than L_9. Ventrianal shield longer than wide, with lateral margins parallel and slightly constricted, and with three pairs of pre-anal setae and a pair of pores (Fig. 155). Two pairs of metapodal plates. Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected in Guatemala. *T. (A.) elongatus* is preoccupied (cf. *T. elongatus* Oudemans, 1930) and the new name *guatemalensis* is proposed for this species. Type locality: orchids from Guatemala, Brownsville, Texas.

***T. (A.) fraterculus* (Berlese) (Figs. 156, 157)**

Amblyseius fraterculus Berlese, 1917: 172.
Typhlodromus fraterculus (Berlese), Chant, 1957a: 300; Figs. 21, 22.

Holotype in Berlese Collection, Florence (No. 8/36).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 156). Setae L_4, L_9, and M_2 long. Setae L_2 and L_3, L_5 and L_6 equal to one another, minute. Ventrianal shield broad, triangular, with lateral margins convex, with three pairs of pre-anal setae (Fig. 157). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Type locality: La Plata, Argentina.

***T. (A.) krantzi* nom. n. (Figs. 158, 159)**

Typhlodromus berlesei Chant, 1957a: 292, 293; Fig. 10.

Holotype in Canadian National Collection (No. 6541).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 158). Details as in *T. (A.) perlongisetus* (p. 84). Setae L_2 and L_3, L_5 and L_6 minute, equal to one another. Setae L_7 and L_8 minute. Setae L_4, L_9, and M_2 very long and whiplike. Ventrianal shield longer than wide, with lateral margins parallel and slightly constricted, and with three pairs of pre-anal setae and a pair of pores (Fig. 159). Three pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. A transverse fold on membrane between ventrianal and genital shields. Leg IV with three macrosetae. Collected in British Columbia. Type locality: *Ranunculus* sp., Nakusp, British Columbia. Dr. Evans (*in litt.*) pointed out that the name under which this mite was described is preoccupied (Oudemans, 1938) and the name *T. (A.) krantzi* is hereby proposed. The species is named in honour of Dr. G. W. Krantz, Oregon State College, Corvallis, Oregon.

***T. (A.) multidentatus* sp.n. (Figs. 160, 161)**

Female.—Length 338 μ; width 230 μ. Dorsal shield heavily sclerotized, smooth, and with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 160). Setae L_1 (27 μ), L_4 (116 μ), L_9 (320 μ), D_1 (27 μ) and M_2 (149 μ) long, remaining setae minute and barely discernible.

Setae S_1 and S_2 minute, on interscutal membrane. Sternal shield with three pairs of setae. One pair of metasternal plates, each with a seta. Genital shield normal. Ventrianal shield oblong, with lateral margins slightly constricted, longer (108 μ) than wide (81 μ), and with three pairs of pre-anal setae (Fig. 161). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long (90 μ), the remainder short or minute. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with many teeth. Legs normal; leg IV with three macrosetae.

Male.—Ventrianal shield with three pairs of pre-anal setae. Chelicera with spermatophoral process.

Diagnosis.—Resembles *T. (A.) perlongisetus* most closely but separated from that species by the extreme minuteness of all setae on the dorsal shield except D_1, L_1, L_4, L_9, and M_2, by the extreme length of L_9, and by the relative lengths of the setae on the membrane surrounding the ventrianal shield.

Locality and Type Material.—The holotype female, two other females, three males, and a nymph, collected from sepal palm at St. Petersburg, Florida, July 11, 1952, by Dr. E. W. Baker, who was aided by a grant from the Pinellas Biological Laboratory, Inc., are in the United States National Museum. One male and one female from cypress at Auburndale, Florida, June 24, 1952, are in the Canadian National Collection at the Belleville laboratory. Additional specimens from Florida have been examined and the species is probably common in that state.

***T. (A.) perlongisetus* (Berlese) (Figs. 162, 163)**

Amblyseius perlongisetus Berlese, 1917: 173.
Typhlodromus perlongisetus (Berlese), Chant, 1957a: 299, 300; Figs. 19, 20.
Amblyseius musae Garman, 1958: 73-74; Fig. 5. *New synonymy.*
Holotype in Berlese Collection, Florence (No. 168/26).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 162). Setae L_2, L_3, L_5, L_6, L_7, and L_8 minute. Setae L_4, L_9, and M_2 whiplike and long. Ventrianal shield much longer than wide, with lateral margins parallel and slightly constricted, and with three pairs of pre-anal setae (Fig. 163). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Argentina, British Columbia, the United States, Haiti, and Cuba. Type locality: La Plata, Argentina. Garman's drawings of *A. musae* are incorrect and an examination of the holotype showed this species to be synonymous with *T. (A.) perlongisetus.*

***T. (A.) herbicolus* sp.n. (Fig. 164)**

Female.—Length 343 μ; width 235 μ. Dorsal shield smooth and having 17 pairs of setae arranged as in *T. (A.) perlongisetus* (Fig. 162).

Ventral surface as in *T. (A.) perlongisetus* except ventrianal shield of different shape. Ventrianal shield much longer (113 μ) than wide (68 μ), vase shaped, with three pairs of pre-anal setae and a pair of distinct pores (Fig. 164). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (59 μ), the remainder short. Two pairs of metapodal plates, one very small.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, with three long macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Similar to *T.* (*A.*) *perlongisetus* but differing in the shape of the ventrianal shield.

Locality and Type Material.—The holotype, collected from bromeliad imported from Portugal at Boston, Massachusetts, August 13, 1955, by Mr. J. D. Crump, is in the United States National Museum. A second female, collected from grass and weeds at Tortola, British West Indies, is in the Canadian National Collection at the Belleville laboratory.

T. (A.) morgani Chant (Figs. 165, 166)

Typhlodromus morgani Chant, 1957a: 294; Figs. 13, 14.

Holotype in Canadian National Collection (No. 6543).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 165). Setae D_1, L_1, L_4, L_9, and M_2 moderately long, remaining setae minute. Setae L_2 and L_3, L_5 and L_6 equal in length. Ventrianal shield wider than long, reticulated, and with three pairs of pre-anal setae and a pair of pores (Fig. 166). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. A pair of small, oval, sclerotized plates on membrane between ventrianal shield and metapodal plates. Two pairs of slender, elongate plates on membrane between genital and ventrianal shields. Leg IV with three macrosetae. Collected in British Columbia and Oregon. Type locality: dandelion, Trout Creek, Summerland, British Columbia.

T. (A.) meridionalis (Berlese) comb. n. (Figs. 301, 302)

Amblyseius obtusus var. *meridionalis* Berlese, 1914: 144; Fig. 56.
Typhlodromus obtusus var. *meridionalis* (Berlese), Chant, 1957a: 306.
Amblyseius meridionalis (Berlese) [sic], Athias-Henriot, 1958: 32; Figs. 10c, 13.

Holotype in Berlese Collection, Florence, Italy.

The holotype is in poor condition and cannot be examined critically. Athias-Henriot collected what she believes to be this species in Algeria and the following diagnosis was prepared from her published drawings.

Dorsal shield (Fig. 301) with 17 pairs of setae, nine in lateral rows. Setae L_1, L_4, L_9, and M_2 long. Remaining setae short or minute. Setae L_2 and L_3, L_5 and L_6 short, equal. Seta D_5 present. Genital shield broad. Ventrianal shield large, irregular (Fig. 302), with three pairs of pre-anal setae and a pair of pores. Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one large, triangular. Two pairs of elongate platelets between genital and ventrianal shields. Six small areas of sclerotization on membrane surrounding genital and ventrianal shields. Collected in Italy and Algeria. Type locality: soil, "Potenza", Italy (?).

T. (A.) floridanus (Muma) comb. n. (Figs. 167, 168)

Amblyseiopsis floridanus Muma, 1955b: 264; Figs. 4, 5.
Amblyseius floridanus (Muma), Athias-Henriot, 1958: 33; Figs. 14, 15c, d.
Amblyseiopsis floridanus Muma, Garman, 1958: 79; Fig. 15.

Holotype in United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 167). Setae L_1, L_4, L_9 and M_2 very long, whiplike. Remaining setae minute. Ventrianal shield triangular, with three pairs of pre-anal setae (Fig. 168). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in Florida. Type locality:

litter under citrus trees, Lake Weir, Florida. Examination of the type specimen showed that Muma's drawings were incorrect; he did not indicate the presence of setae L_6 and L_7.

***T. (A.) longulus* (Berlese) (Figs. 169, 170)**

Amblyseius longulus Berlese, 1914: 145; Plate IV, Fig. 58.
Amblyseius longulus Berlese, Willmann, 1952: 149.
Amblyseius longulus Berlese, Womersley, 1954: 190.
Typhlodromus longulus (Berlese), Chant, 1957a: 302, 303; Figs. 27, 28.
Holotype in Berlese Collection, Florence (No. 115/18).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 169). Setae L_4, L_9, and M_2 long. Setae L_2 and L_3, and L_5 and L_6 short, equal in length. Ventrianal shield broad, triangular, with lateral margins convex, and with three pairs of pre-anal setae (Fig. 170). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected only in Italy. Type locality: moss, "Palaia", Italy.

***T. (A.) caudatus* (Berlese) (Figs. 171, 172)**

Amblyseius caudatus Berlese, 1914: 145; Plate IV, Fig. 60.
Amblyseius caudatus Berlese, Womersley, 1954: 190.
Typhlodromus caudatus (Berlese), Chant, 1957a: 306, 308; Figs. 33-35.
Holotype in Berlese Collection, Florence (No. 133/40).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 171). Setae L_4, L_9, and M_2 moderately long. Setae L_2 and L_3, L_5 and L_6 minute, equal in length. The true identity of this species cannot be determined because the ventral surface of the type specimen cannot be examined. Some acarologists believe that it has a flask-shaped ventrianal shield that places it in the *newsami* group; others believe that it has a triangular ventrianal shield that places it in the *obtusus* group. If the latter is true, then the description reads as follows: ventrianal shield triangular, broad, with lateral margins converging posteriorly and convex, with three pairs of pre-anal setae and a pair of pores (Fig. 172). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Specimens with the ventrianal shield triangular have been reported from Java and Germany, though I consider the latter record to be based on a misidentification. Type locality: "Java".

***T. (A.) lichenis* sp.n. (Figs. 174, 175)**

Female.—Length 365 μ; width 208 μ. Dorsal shield smooth, with 16 pairs of setae, nine in the lateral, two in the median, and five in the dorsal rows (Fig. 174). Setae L_1 to L_3 short and equal in length (approximately 27 μ). Setae L_4, L_6, L_9, and M_2 long (41, 59, 63, and 63 μ respectively) and curved. Seta L_5 (9 μ) much shorter than L_6. Setae L_7 and L_8 minute. Seta D_5 absent, its position marked by a pair of pores. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Seta S_1 and S_2 on interscutal membrane. Peritreme broad and with short, almost straight, truncate, posterior projection extending beyond base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates large, oval, and with fourth pair of setae. Genital shield normal. Ventrianal shield slightly reticulated, longer (126 μ) than wide (113 μ), approximately triangular, with anterior margin straight, lateral margins slightly convex, posterior margin rounded, and with three pairs of pre-anal setae and a pair of pores (Fig. 175). Three pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (54 μ), the remainder short. Two pairs of metapodal plates, one large, the other minute.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with four teeth and large pilus dentilis; movable digit with one tooth. Legs normal, with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the chaetotaxy of the dorsal shield.

Locality and Type Material.—One female, collected from moss and lichens on the western slope of "Mount Popocatepetl", Mexico, at 9,000 feet above sea level, December 29, 1942, by Dr. E. W. Baker, is in the United States National Museum.

***T. (A.) collyerae* sp.n. (Figs. 176, 177)**

Female.—Length 324 μ; width 185 μ. Dorsal shield smooth, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 176). Setal measurements as follows: L_1 32 μ; L_2 27 μ; L_3 29 μ; L_4 49 μ; L_5 14 μ; L_6 41 μ; L_7 and L_8 14 μ; L_9 68 μ; M_2 59 μ. Therefore, seta L_5 much shorter than L_6. Setae L_1 to L_4 longer than distances between their bases. Remaining setae short, except D_1. Bases of setae L_7 and M_2 closer to one another than to that of L_8. Three pairs of pores on dorsal shield, associated with setae L_7, L_8, and L_5.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with long, hooked, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, with a fourth pair of setae. Genital shield normal. Ventrianal shield faintly reticulated, as wide as long (99 μ), triangular, with three pairs of pre-anal setae (Fig. 177). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (59 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of positions of specimens. Legs normal, with three long macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Resembling *T.* (*A.*) *umbraticus* but differing from it by having L_7 and L_8 shorter, L_9 and M_2 longer, and differently shaped metapodal plates. Also resembling *T.* (*A.*) *okanagensis* but in that species seta D_5 is absent, and the metapodal plates and ventrianal shield are shaped differently.

Locality and Type Material.—The holotype, collected from *Rubus* sp. in Burbridge's Orchard, East Malling, Kent, England, July 10, 1954, is in the Canadian National Collection (No. 6855). Two females from *Rubus* sp., the Quarry, East Malling, July 18, 1954, and from the same host plant species at Newgates Shaw, East Malling, February 9, 1954, are in the Canadian National Collection at the Belleville laboratory. All were collected by the author. The species is named in honour of Dr. Elsie Collyer, East Malling Research Station.

***T. (A.) britannicus* sp.n. (Figs. 178, 179)**

Female.—Length 343 μ; width 186 μ. Dorsal shield smooth, and having 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 178). Setae L_1, L_4, L_9, and M_2 long (45, 70, 145, and 68 μ respectively). Remaining setae short, except D_1. Setae L_2 and L_3 short and equal in length. Seta L_5 shorter (7 μ) than L_6 (14 μ). Seta L_9 slightly serrated. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad with stout, truncate, posterior projection curving slightly around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, oval, and with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (115 μ)

than wide (86 μ), triangular, and with three pairs of pre-anal setae and a pair of pores (Fig. 179). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (59 μ), the remainder short. Two pairs of metapodal plates, one minute, the other broad and almost oval.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with many teeth; movable digit impossible to examine because of position of specimens. Legs normal, with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the relative lengths of setae L_2 and L_3, and of L_5 and L_6, and by the shape of the ventrianal shield.

Locality and Type Material.—The holotype and another female, collected from apple leaves at Penlan Hall, near Fordham, Essex, England, September 19, 1953, are in the Canadian National Collection (No. 6856). Four females collected from *Convolvulus* sp. at Headcorn, Kent, September 8, 1954, are in the Canadian National Collection at the Belleville laboratory. One female, collected from ash (*Fraxinus excelsior* L.) in Oaken Wood, East Malling, Kent, September 11, 1954, is in the United States National Museum. One female, collected from *Rubus* sp., the Quarry, East Malling, January 11, 1954, is in the British Museum (Natural History), London. Additional specimens have been examined as follows: from bracken (*Pteridium* sp.) six miles south of Ashford, Kent; from apple bark, Ulcombe, Kent; and from peach leaves, Wheathamsted, Herts. All specimens were collected by the author.

T. (A.) aerialis comb. n. (Muma) (Figs. 180, 181)

Amblyseiopsis aerialis Muma, 1955b: 264, 266; Figs. 7-9.
Amblyseius aeralis (Muma) [sic], Athias-Henriot, 1957a: 338-339; Figs. 5A, B.
Amblyseius aeralis (Muma) [sic], Athias-Henriot, 1958: 34; Figs. 12B, 15B.
Amblyseiopsis aeralis Muma [sic], Garman, 1958: 75; Fig. 7.

Holotype in United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 180). Setae L_1, L_4, L_9, and M_2 long. Seta L_2 approximately equal to L_3; seta L_6 longer than L_5. Setae L_2, L_5, L_7, L_8 short, approximately equal. Ventrianal shield rectangular, longer than wide, with three pairs of pre-anal setae and a pair of pores (Fig. 181). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Eastern North America, Bermuda, Mexico, Honduras, and Louisiana. Type locality: citrus leaf, Lucerne Park, Florida.

T. (A.) schusteri sp.n. (Figs. 182, 183)

Female.—Length 365 μ; width 241 μ. Dorsal shield as in *T. (A.) britannicus* except setae L_1, L_4, L_9, and M_2 longer, L_9 not serrated (Fig. 182). Ventral surface as in *T. (A.) britannicus* except ventrianal shield broader and with moderate lateral constrictions (Fig. 183). Two metapodal plates.

Gnathosoma and maxillary palps normal. Chelicera with many teeth. Legs normal, legs III and IV with three macrosetae each.

Male.—Unknown.

Diagnosis.—Similar to *T. (A.) britannicus* but differing in the lengths of some lateral setae on the dorsal shield, and in the shape of the ventrianal shield.

Locality and Type Material.—The holotype and two other females, collected by Mr. R. Schuster (in whose honour the species is named) at Kaiser Pass, Fresno County, California, in August, 1956, are in the Canadian National Collection (No. 6857).

T. (A.) graminis (Chant) comb. n. (Figs. 184, 185)

Amblyseius graminis Chant, 1956: 34-36; Figs. 5, 6.
Amblyseius graminis Chant, Athias-Henriot, 1957a: 338.

Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 184). Setae L_1, L_4, L_9, and M_2 moderately long. Setae L_2 and L_3 short, equal in length. Seta L_6 much longer than L_5. Setae L_7 and L_8 minute. Ventrianal shield triangular, broad, with three pairs of pre-anal setae and a pair of pores (Fig. 185). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in England and Algeria. Closely resembling *T. (A.) britannicus* but seta L_9 is much shorter than in that species. Type locality: grass, East Malling, Kent, England.

T. (A.) neomexicanus nom. n. (Figs. 186, 187)

Amblyseiopsis reticulatus Garman, 1958: 77-78; Fig. 11.

Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 186). Seta D_5 absent, its position marked by a pore. Setae L_1, L_2, L_4, L_6, L_9, and M_2 long, remaining setae short or minute. Ventrianal shield triangular, faintly reticulated, with three pairs of pre-anal setae and a pair of pores (Fig. 187). Two pairs of metapodal plates. Two pairs of elongate sclerotized plates lying on membrane between genital and ventrianal shields. One pair of minute, oval, sclerotized plates lying on membrane between genital and ventrianal shields. Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected in New Mexico. Type locality: "*Neorama plaigula*", Santa Fe, New Mexico. Garman's drawings do not show seta L_5. *T. (A.) reticulatus* is preoccupied (cf. Oudemans, 1930) and the new name *neomexicanus* is proposed for this species.

T. (A.) rademacheri (Dosse) comb. n.

Amblyseius rademacheri Dosse, 1958a: 44-48; Figs. 1-5.
Amblyseius rademacheri Dosse, Dosse, 1958b: 9; Fig. 18.
Amblyseius rademacheri Dosse, Ehara, 1959: 288-290; Figs. 6-11.

Holotype in Institut für Pflanzenschutz der Landwirtschaftlichen Hochschule, Stuttgart-Hohenheim, Germany.

Dorsal shield reticulated and with 17 pairs of setae, nine in the lateral rows. Setae L_4, L_9, and M_2 longer, remaining setae short or minute. Setae L_1 and D_1 equal. Setae L_2 and L_6 slightly longer than L_3 and L_5 respectively. Setae L_9 and M_2 serrated. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores. Four pairs of setae on membrane surrounding ventrianal shield. Type locality: apple tree, Stuttgart-Hohenheim, Germany.

T. (A.) fragariae (Kennett) comb. n. (Figs. 188, 189)

Amblyseius fragariae Kennett, 1958: 475-476; Figs. 13-20.

Holotype in United States National Museum.

Dorsal shield smooth (Fig. 188) and having 16 pairs of setae, nine in the lateral rows. Seta D_5 absent. Seta M_2 long. Setae L_1 and L_2 equal in length, L_3 less than half their length. Seta L_4 equal in length to L_9. Setae L_5, L_7, and L_8 short, L_6 moderately long, shorter than M_2. Setae S_1 and S_2 present. Sternal shield reticulated. Genital shield very broad, otherwise normal. Ventrianal shield reticulate, as wide as long, with three pairs of pre-anal setae (Fig. 189). Four pairs of setae on membrane surrounding ventrianal shield. One pair of

metapodal plates. Leg IV with three macrosetae. Setae on all tarsi somewhat longer than normal. Collected in California and British Columbia. Type locality: strawberry leaves, Coyote, Santa Clara Co., California.

T. (A.) exopodalis (Kennett) comb. n. (Figs. 299, 300)

Amblyseius exopodalis Kennett, 1958: 476-477; Figs. 27-34.

Holoype in United States National Museum.

Dorsal shield (Fig. 299) lightly sclerotized, with 16 pairs of setae, nine in lateral rows. Seta D_5 absent. Setae L_2 longer than L_3; L_6 longer than L_5. Setae L_1, L_2, L_4, L_9, M_2 moderately long, robust. Sternal shield smooth. Genital shield narrow. Ventrianal shield longer than wide, constricted anteriorly (Fig. 300), with three pairs of pre-anal setae and a pair of pores. Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected only in California. Type locality: strawberry leaves, Santa Maria, California.

T. (A.) foenalis (Berlese) (Figs. 190, 191)

Amblyseius foenalis Berlese, 1914: 144; Plate IV, Fig. 54.
Amblyseius foenalis Berlese, Womersley, 1954: 190.
Amblyseius foenalis Berlese, Athias-Henriot, 1957a: 340.
Typhlodromus foenalis (Berlese), Chant, 1957a: 300, 302; Figs. 23, 24.
Amblyseius foenalis Berlese, Athias-Henriot, 1958: 29-31; Figs. 11, 12A.

Holotype in Berlese Collection, Florence, Italy.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 190). Setae L_4, L_9, and M_2 moderately or very long. Setae L_1 and L_2 much longer than L_3, equal to one another. Setae L_5 and L_6 short, equal to one another. Setae L_7 and L_8 minute. Ventrianal shield broad, triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 191). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected only in Italy. Type locality: Florence.

T. (A.) obtusus (Koch) (Figs. 192, 193)

Zercon obtusus Koch, 1839: Fasc. 27, Fig. 13.
Zercon obtusus Koch, Canestrini and Fanzago, 1876: ser. ii.
Sejus obtusus (Koch), Berlese, 1889: 7.
Amblyseius obtusus Berlese (ex. Koch) [sic], Berlese, 1914: 144; Plate IV, Fig. 55.
Zercon obtusus Koch, Oudemans, 1930: 71.
Amblyseius obtusus (Koch), Womersley, 1954: 188-189; Fig. 12.
Amblyseius obtusus Berlese, Athias-Henriot, 1957a: 340-341.
Typhlodromus obtusus (Berlese) (ex. Koch) [sic], Chant, 1957a: 306; Figs. 31, 32.
Non *Amblyseius obturus* [sic] Athias-Henriot, 1958: Figs. 10A, B.

Berlese's specimens in Berlese Collection, Florence (Nos. 19/10 and 22/14).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 192). Setae L_4, L_9, and M_2 long. Setae L_1 and L_2 equal in length. Seta L_3 short, half as long as L_1 or L_2. Setae L_5 and L_6 minute and equal to one another. Ventrianal shield triangular, with rounded, converging lateral margins, and with three pairs of pre-anal setae (Fig. 193). Four pairs of setae surrounding ventrianal shield. One pair of small metapodal plates. Leg IV with three macrosetae. Collected in Italy and Western Canada. Berlese's specimens were collected in moss and soil.

T. (A.) ovatus (Garman) comb. n. (Figs. 194, 195)

Amblyseiopsis ovatus Garman, 1958: 78; Fig. 13.

Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 194). Seta D_5 absent. Setae L_1, L_2, L_4, L_9, and M_2 moderately long. Setae L_3, L_5 L_6, L_7,

and L_8 short and approximately equal to one another. Ventrianal shield triangular, striated, with three pairs of pre-anal setae and a pair of pores (Fig. 195). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Two pairs of elongate, sclerotized plates lying on membrane between ventrianal and genital shields. One pair of minute, oval, sclerotized plates on membrane just laterad of the two pairs of elongate plates. Leg IV with three macrosetae. Garman omitted setae L_6 and L_7 from his drawings. Type locality: on *Cattleya* sp. from Ecuador, Brownsville, Texas.

***T. (A.) oregonensis* (Garman) comb. n. (Figs. 196, 197)**

Amblyseiopsis oregonensis Garman, 1958: 78-79; Fig. 14.

Holotype in United States National Museum (No. 7, Lot 52-12630).

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 196). Seta D_5 absent. Setae L_1, L_4, L_9, and M_2 long. Seta L_3 slightly longer than L_2, both short. Setae L_5, L_6 L_7, and L_8 short, equal to one another. Ventrianal shield triangular with lateral margins nearly parallel, with three pairs of pre-anal setae and a pair of pores (Fig. 197). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Two pairs of elongate, sclerotized plates on membrane between ventrianal and genital shields. One pair of minute, oval, sclerotized plates laterad of membrane between genital and ventrianal shields. Leg IV with three macrosetae. Collected in Oregon and Connecticut. Type locality: ladino clover, Grants Pass, Oregon. Garman omitted setae L_5 and L_7 from his drawings.

***T. (A.) putmani* sp.n. (Figs. 198, 199)**

Female.—Length 370 μ; width 250 μ. Dorsal shield (Fig. 198) as in *T. (A.) tropicanus*. Ventral surface as in *T. (A.) tropicanus* (Fig. 201) except: ventrianal shield of characteristic shape (Fig. 199) with three pairs of pre-anal setae and without pores. Two pairs of metapodal plates, differing in shape and size from those of *T. (A.) tropicanus*.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with six teeth; movable digit with one tooth. Legs normal, leg III with one macroseta, leg IV with three macrosetae.

Male.—Unknown.

Diagnosis.—Similar to both *T. (A.) tropicanus* and *T. (A.) mexicanus* but differing in the shape of the ventrianal shield.

Locality and Type Material.—The holotype and five additional females, collected from soil debris in a peach orchard at Vineland, Ontario, by Mr. W. Putman (in whose honour the species is named), March 29, 1954, are in the Canadian National Collection (No. 6859).

***T. (A.) tropicanus* (Garman) comb. n. (Figs. 200, 201)**

Amblyseiopsis tropicanus Garman, 1958: 77; Fig. 10.

Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 200). Seta D_5 absent. Setae L_4, L_9, and M_2 long. Seta L_1 longer than L_2, in turn longer than L_3. Setae L_5, L_6, L_7, L_8 short, equal to one another. Ventrianal shield approximately triangular, with lateral margins sharply constricted, with three pairs of pre-anal setae and a pair of pores (Fig. 201). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, the smallest much larger than shown in Garman's drawings. Leg IV with three macrosetae. Collected in Florida and Louisiana. Garman omitted L_5 and L_6 from his drawings. Type locality: Bermuda grass, Homestead, Florida.

***T. (A.) mexicanus* (Garman) comb. n. (Figs. 202, 203)**

Amblyseiopsis mexicanus Garman, 1958: 75; Fig. 6.
Amblyseius obturus [sic] Berlese, Athias-Henriot, 1958: Figs. 10A, B.
Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 202). Seta D_5 absent. Setae L_4, L_9, and M_2 long. Seta L_1 longer than L_2, in turn longer than L_3. Setae L_5, L_6, L_7, and L_8 short, equal to one another. Ventrianal shield approximately triangular, with lateral margins parallel, posterior margin rounded, with three pairs of pre-anal setae and a pair of pores (Fig. 203). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in Algeria, Mexico, and West Virginia. Type locality: zinnia from Mexico at Brownsville, Texas. Garman omitted setae L_5, L_7, and L_8 from his drawings and included two ventral setae on his drawing of the dorsal shield.

***T. (A.) andersoni* Chant (Figs. 204, 205)**

Typhlodromus andersoni Chant, 1957a: 296; Figs. 17, 18.
Amblyseius andersoni (Chant), Athias-Henriot, 1958: 33; Fig. 15B.
Holotype in Canadian National Collection (No. 6545).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 204). Setae L_1, L_4, L_9, and M_2 moderately or very long. Seta L_3 longer than L_2. Seta L_6 longer than L_5. Setae L_7 and L_8 minute. Ventrianal shield long, with lateral margins parallel, with three pairs of pre-anal setae and a pair of pores (Fig. 205). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in British Columbia, Ontario, Oregon, and Japan. Type locality: prune leaves, Rosedale, British Columbia.

***T. (A.) tsugawai* (Ehara) comb. n.**

Amblyseius tsugawai Ehara, 1959: 290-291; Figs. 12, 13.
Holotype in the Amori Prefectural Apple Experiment Station, Japan.

This species resembles very closely *T. (A.) andersoni*, apparently differing from it only in the relative lengths of the macrosetae on leg IV (and not in the shape of the ventrianal shield as Ehara believed). I have not examined specimens of this species and therefore am unable to decide if it is valid or merely a variant of *andersoni*.

***T. (A.) septus* (Garman) comb. n. (Figs. 206, 207)**

Amblyseiopsis septa Garman, 1958: 78; Fig. 12.
Holotype in United States National Museum.

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 206). Seta D_5 absent. Setae L_1, L_2, L_3, L_4, L_6, L_9, and M_2 long but not whiplike. Seta L_3 slightly longer than L_2. Seta L_6 much longer than L_5, which is short. Setae L_7 and L_8 short. Ventrianal shield triangular, with three pairs of pre-anal setae and a pair of pores (Fig. 207). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Two pairs of elongate, sclerotized plates on membrane between ventrianal and genital shields. Leg IV with three macrosetae. Type locality: orchids from Mexico at Brownsville, Texas. Garman omitted setae L_5, L_7, and L_8 from his drawings and included a seta laterad of M_2 that is really only a pore.

***T. (A.) okanagensis* Chant (Figs. 208, 209)**

Typhlodromus okanagensis Chant, 1957a: 293, 294; Figs. 11, 12.

Holotype in Canadian National Collection (No. 6542).

Dorsal shield with 16 pairs of setae, nine in the lateral rows (Fig. 208). Seta D_5 absent. Setae L_1, L_3, L_4, L_9, and M_2 moderately long. Seta L_3 much longer than L_2. Seta L_6 longer than L_5. Setae L_7 and L_8 minute. Eight pairs of minute pores on dorsal shield. Ventrianal shield reticulated, triangular, with lateral margins convex, with three pairs of pre-anal setae and a pair of pores (Fig. 209). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Five pairs of minute, sclerotized plates on membrane between ventrianal shield and metapodal plates. Two pairs of elongate, sclerotized plates on membrane between ventrianal and genital shields. Collected only in British Columbia. Type locality: peach leaves, Oliver, British Columbia.

***T. (A.) potentillae* (Garman) comb. n. (Figs. 210, 211)**

Amblyseiopsis potentillae Garman, 1958: 76-77; Fig. 9.

Holotype in United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 210). Setae L_1, L_4, L_9, and M_2 long. Seta L_3 longer than L_2. Seta L_6 slightly longer than L_5. Setae L_7 and L_8 minute. Ventrianal shield almost square with anterior margin rounded, lateral margins slightly constricted, with three pairs of pre-anal setae and a pair of pores (Fig. 211). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Two pairs of elongate, sclerotized plates on membrane between ventrianal and genital shields. Leg IV with three macrosetae. Garman omitted setae L_7 and L_8 from his drawings, and he showed setae D_5 and D_4 somewhat longer than is the case. Type locality: *Potentilla* sp. from Holland at Hoboken, New Jersey.

***T. (A.) similis* (Koch) (Figs. 212, 213)**

Zercon similis Koch, 1839: Fasc. 27, Fig. 6.
Typhlodromus similis (Koch), Kuenen, 1946: 31-32; Fig. 8.
Amblyseius similis (Koch), Kuenen, 1947: 303-312.
Typhlodromus similis (Koch), Nesbitt, 1951: 2.
Typhlodromus similis (Koch), Cunliffe and Baker, 1953: 14; figures.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 212). Setae L_1, L_4, L_9, and M_2 long. Setae L_3 much longer than L_2. Setae L_5, L_7, and L_8 minute, equal to one another. Seta L_6 longer than L_5. Ventrianal shield long, narrow, with lateral margins parallel, with three pairs of pre-anal setae and a pair of pores (Fig. 213). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Germany, Italy, France, Belgium, Austria, Java, Holland, Mexico, California, and Texas. Type locality: Germany.

Oudemans (1930) also claimed that *Zercon ovalis* Koch, 1839, *Z. pallens* Koch, 1839, *Z. obtusus* Koch, 1839, and *Seiulus truncatus* Oudemans, 1905 are synonyms of *similis*. I do not know how Oudemans reached this conclusion and do not accept it.

It is not known how modern authors connected this species with that described by Koch more than 100 years ago; Koch's drawing is inadequate for specific identification and his specimens are lost. Modern authors most commonly described under this name a species that is abundant in California on citrus, avocado, and other host plants. This almost certainly is not conspecific with

Koch's specimens as the latter were from the Palearctic region. Because of this usage, however, and because it is now impossible to determine the exact status of Koch's species I feel it would be undesirable to describe the California form as new. Under the circumstances, I do not feel that I can designate a neotype from North American material.

Cunliffe and Baker showed seta L_6 equal in length to L_5, but I have examined the specimen from which their description was prepared and found L_6 to be much longer than L_5.

***T. (A.) americanus* comb. n. (Garman) (Figs. 214, 215)**

Amblyseius americanus Garman, 1948: 17; Figs. 9, 10.
Amblyseius americanus Garman, Cunliffe and Baker, 1953: 25; figures.
Amblyseiopsis americanus (Garman), Garman, 1958: 74.

Holotype in Connecticut Agricultural Experiment Station collection, New Haven.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 214). Setae D_1, L_1, L_4, L_9, and M_2 long, some whiplike. Seta L_3 longer than L_2. Setae L_5 and L_6 equal to one another. Setae L_7 and L_8 minute. Ventrianal shield longer than wide, with anterior margin straight, lateral margins straight and parallel, posterior margin rounded, with three pairs of pre-anal setae (Fig. 215). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Leg IV with three long macrosetae. Collected in Canada and the United States. Type locality: apple bark and leaves, Connecticut. Cunliffe and Baker show only two pairs of pre-anal setae but examination of the type specimen revealed three pairs, as originally described by Garman. However, Garman omitted seta L_5 from his drawing.

***T. (A.) silvaticus* sp.n. (Figs. 216, 217)**

Female.—Length 365 μ; width 230 μ. Dorsal shield smooth, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 216). Setae L_1, L_4, L_9, and M_2 long (54, 117, 158, and 230 μ respectively). Seta L_2 (23 μ) shorter than L_3 (36 μ). Setae L_5 and L_6 equal to one another, minute. Remaining setae minute, except D_1. Bases of setae L_7 and M_2 much closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad, with stout, hooked, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates oval, with fourth pair of setae. Genital shield normal. Ventrianal shield longer (122 μ) than wide (99 μ), with anterior margin straight, lateral margins parallel, posterior margin rounded, with three pairs of pre-anal setae (Fig. 217). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long (95 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with many denticules and two teeth; movable digit with four teeth. Legs normal, with two macrosetae on leg III, and three very long macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Resembling *T. (A.) similis* but differs in that setae L_1, L_4, L_9, and M_2 are much longer, and the ventrianal shield is more nearly triangular in shape.

Locality and Type Material.—The holotype, collected from the bark of *Picea* sp. at Feldmeilen, Switzerland, November 24, 1955, is in the Canadian National Collection (No. 6861). Three other females, collected from apple bark at Ulcombe, Kent, England, during the winter of 1955, are in the Canadian

National Collection at the Belleville laboratory. All specimens were collected by the author.

***T. (A.)gracilis* (Garman) comb. n. (Figs. 218, 219)**

Amblyseiopsis gracilis Garman, 1958: 79; Fig. 16.
Amblyseius orientalis Ehara, 1959: 291-293; Figs. 14-16. ***New synonymy.*** (Type locality: *Quercus* sp., Sapporo, Japan.)
Holotype in the United States National Museum (Lot 46-5209).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 218). Setae L_1, L_4, L_9, and M_2 long. Seta L_3 slightly longer than L_2. Setae L_5, L_6, L_7, and L_8 minute, equal to one another. Ventrianal shield triangular, with posterior margin rounded, with three pairs of pre-anal setae and a pair of pores (Fig. 219). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. One pair of minute, oval, sclerotized plates on membrane between ventrianal and genital shields. Leg III with two macrosetae, leg IV with three macrosetae. Collected in Oregon and Japan. Type locality: mullein, Portland, Oregon. Garman omitted setae L_5, L_6, L_7, and L_8 from his drawings.

T. newsami Group

Dorsal shield with 17 pairs of setae, nine in the lateral rows. Ventrianal shield vaselike (Fig. 221), with lateral margins constricted and forming a waist, then flaring to cause shield to be widest opposite anus, and with three pairs of pre-anal setae arranged in a triangular pattern with two pairs on or near margins of shield.

Key to Species of *newsami* Group

1. Seta M_2 minute (Fig. 222) 2
   Seta M_2 longer (Figs. 226, 171) 4
2. Setae L_1 and L_4 much longer than other lateral setae except L_9 (Fig. 222) 3
   Setae L_1 and L_4 not much longer than other lateral setae except L_9 (Fig. 220) ..... *T. (A.) newsami* Evans
3. One pair of setae on membrane surrounding ventrianal shield (Fig. 223) ..... *T. (A.) africanus* Evans
   Four pairs of setae on membrane surrounding ventrianal shield (Fig. 225) ..... *T. (A.) limonicus* (Garman and McGregor)
4. Setae L_1, L_4, L_9, and M_2 much longer than remaining setae on dorsal shield (Fig. 226) 5
   Setae L_1 and L_4 not greatly longer than remaining setae on dorsal shield (Fig. 230) 6
5. Setae L_4 and M_2 extremely long and whiplike (Fig. 226) ..... *T. (A.) largoensis* (Muma)
   Setae L_4 and M_2 shorter and not whiplike (Fig. 171) ..... *T. (A.) caudatus* (Berlese)
6. Seta D_1 twice as long as L_2 or L_3 (Fig. 228) 7
   Seta D_1 not twice as long as L_2 or L_3 (Fig. 230) 8
7. Setae L_2 and L_3 equal ..... *T. (A.) peregrinus* Muma
   Seta L_3 longer than L_2 ..... *T. (A.) jucundus* sp.n.
8. Seta L_7 less than twice as long as L_8 (Fig. 230) ..... *T. (A.) robiniae* sp.n.
   Seta L_7 more than twice as long as L_8 (Fig. 234) 9
9. Sternal shield with two pairs of setae; two pairs of metasternal plates ..... *T. (A.) leucophaeus* (Athias-Henriot) comb. n.
   Sternal shield with three pairs of setae; one pair of metasternal plates 10
10. Lateral margins of ventrianal shield straight and only slightly divergent posteriorly (Fig. 235); seta M_2 usually smooth ..... *T. (A.) evansi* sp.n.
    Lateral margins of ventrianal shield markedly convex opposite anus, forming a 'bulb' (Fig. 237); seta M_2 usually serrated ..... *T. (A.) primulae* sp.n.

***T. (A.) newsami* Evans (Figs. 220, 221)**

Typhlodromus newsami Evans, 1953: 450-458; Figs. 1-4.

Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 220). Setae D_1 and L_9 moderately long, remaining setae short. Seta M_2 short. Ventrianal shield much longer than wide, with lateral margins markedly constricted and forming a waist, then flaring to make shield widest opposite anus, and with three pairs of pre-anal setae and a pair of pores (Fig. 221). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected only in Malaya. Type locality: "Malaya".

***T. (A.) africanus* Evans (Figs. 222, 223)**

Typhlodromus africanus Evans, 1954: 524-526; Figs. 10-13.

Holotype in British Museum (Natural History).

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 222). Setae D_1, L_1, L_4, and L_9 long, remainder short or minute. Setae L_2 and L_3, L_5 and L_6 equal in length. Ventrianal shield much longer than wide, with lateral margins slightly constricted and forming a waist, with three pairs of pre-anal setae and a pair of pores (Fig. 223). Only one pair of setae on membrane surrounding ventrianal shield. Metapodal plates absent, but three pairs of minute, sclerotized plates on membrane between ventrianal and genital shields. Leg IV with three macrosetae. Collected only in Tanganyika. Type locality: coffee leaves, Lyumungu, Tanganyika.

***T. (A.) limonicus* (Garman and McGregor) comb. n. (Figs. 224, 225)**

Amblyseius limonicus Garman and McGregor, 1956: 11-13; Plate 5, Figs. 1-6.
Non *Amblyseiopsis limonicus* Garman, 1958: 72; Fig. 3.

Holotype in Connecticut Agricultural Experiment Station, New Haven.

Dorsal shield smooth, with 17 pairs of setae, nine in the lateral rows (Fig. 224). Setae L_1, L_4, and L_9 moderately long, M_2 minute. Remaining setae minute except D_1. Setae L_2 and L_3, L_5 and L_6 approximately equal to one another. Bases of setae M_2 and L_7 closer to one another than to that of L_8. A pore sometimes associated with seta L_8. Ventrianal shield much longer than wide, vase shaped, with acute constriction of lateral margins, and with three pairs of pre-anal setae and a pair of pores (Fig. 225). Four pairs of setae on membrane surrounding ventrianal shield. One pair of long, slender, metapodal plates. Fixed digit of chelicera with seven or eight denticules and pilus dentilis; movable digit with three small teeth. Legs normal, with three long macrosetae on leg IV. Collected in California and Florida. Type locality: lemon leaves, California.

***T. (A.) largoensis* (Muma) comb. n. (Figs. 226, 227)**

Amblyseiopsis largoensis Muma, 1955: 266; Figs. 10, 11.
Amblyseiopsis largoensis Muma, Garman, 1958: 76; Fig. 8.
Amblyseius largoensis (Muma), Ehara, 1959: 293-294; Figs. 17-18.

Holotype in United States National Museum.

Muma's description and figures of this species are incorrect; he omitted seta L_7 on the dorsal shield though it is present on his holotype and paratypes, which were examined by me in the United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 226). Setae D_1, L_1, L_4, L_9, and M_2 long or very long. Setae L_2 and L_3, and L_5 and L_6 minute, equal to one another. Remaining setae minute. Ventrianal shield with lateral margins flaring markedly at anus to make shield widest at this point, with three pairs of pre-anal setae and a pair of pores (Fig. 227). Four pairs of setae

on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in Florida, Guatemala, and Mexico. Type locality: lime leaves, Key Largo, Florida.

***T. (A.) caudatus* (Berlese) (Figs. 171, 173)**

Amblyseius caudatus Berlese, 1914: 145; Plate IV, Fig. 60.
Amblyseius caudatus Berlese, Womersley, 1954: 190.
Typhlodromus caudatus (Berlese), Chant, 1957a: 306, 308; Figs. 33-35.
Holotype in Berlese Collection, Florence (No. 133/40).

Chant discussed the difficulty of identifying this species; two different species are known by this name. The one described here is that which Dr. G. Owen Evans (*in litt.*) considers to be correct, and the other was described above with the *obtusus* group.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 171). Setae L_1, L_4, L_9, and M_2 long or very long. Setae L_2 and L_3, L_5 and L_6 short and equal to one another. Remaining setae short. Ventrianal shield much longer than wide, with lateral margins slightly concave and forming a waist, and with three pairs of pre-anal setae and a pair of pores (Fig. 173). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Java, Mauritius, and Hawaii. Type locality: "Java".

***T. (A.) peregrinus* Muma (Figs. 228, 229)**

Typhlodromus peregrinus Muma, 1955b: 270-271; Figs. 22, 24.
Holotype in United States National Museum.

Dorsal shield with 17 pairs of setae, nine in the lateral rows (Fig. 228). Setae D_1, L_1, and L_9 long, setae L_4 and M_2 moderately long, remaining setae short. Setae L_9 and M_2 serrated. Setae L_2 and L_3 equal to one another. Seta L_6 slightly longer than L_5. Ventrianal shield much longer than wide, with lateral margins constricted to form a waist, with three pairs of pre-anal setae and a pair of pores (Fig. 229). Four pairs of setae on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected only in Florida. Type locality: scaly orange leaves, Minneola, Florida.

***T. (A.) jucundus* sp.n. (Figs. 230, 231)**

Female.—Length 335 μ; width 178 μ. Dorsal shield reticulated, with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 230). All setae short except D_1, L_1, L_4, L_9, and M_2 (27, 31, 43, 68, and 43 μ respectively). Setae L_2 and L_3 shorter than L_1 and L_4, and L_3 slightly longer than L_2. Seta L_5 approximately half as long as L_6. Setae L_9 and M_2 distinctly serrated, remaining setae smooth. Bases of setae L_7, L_8, and L_9 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme narrow, with slender, hooked, posterior projection curving around base of coxa IV. Sternal shield normal with three pairs of setae. Metasternal plates large and with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (99 μ) than wide (58 μ), vase shaped, with lateral margins markedly constricted and anterior margin gently convex, with three pairs of pre-anal setae and a pair of pores (Fig. 231). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (45 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with seven denticules and pilus dentilis; movable digit with one tooth. Legs normal, with three long (80 μ) macrosetae on leg IV.

Male.—Ventrianal shield with three pairs of pre-anal setae. Movable digit of chelicera with spur shaped spermatophoral process.

Diagnosis.—Distinguished by the character of the dorsal shield, the relative lengths and characters of the lateral setae on the shield, and by the shape of the ventrianal shield. It is unusual for mites of the subgenus *Amblyseius* to have strongly reticulated dorsal shields and serrated setae.

Locality and Type Material.—The holotype, a female, and five additional females, collected from "*Acer rubrum*" at Ft. Washington, Maryland, July 27, 1953, by Dr. E. W. Baker, are in the United States National Museum. Also in the collection are four females and three males collected from oak at Cabin John, Maryland, September 17, 1951. Four females collected from *A. rubrum* at Washington, D.C., August 9, 1953, are in the Canadian National Collection at the Belleville laboratory.

T. (A.) robiniae sp.n. (Figs. 232, 233)

Female.—Length 324 μ; width 208 μ. Dorsal shield reticulated, and having 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 232). Measurements of lateral setae and M_2 as follows: L_1 35 μ; L_2 23 μ; L_3 27 μ; L_4 43 μ; L_5 14 μ; L_6 27 μ; L_9 78 μ; M_2 45 μ. Setae L_2 and L_3 shorter than other anterior lateral setae, and approximately equal in length. Seta L_5 half as long as L_6. Setae L_7 and L_8 short. Setae L_9 and M_2 serrated. Remaining setae short. Bases of setae L_7, L_8, and M_2 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with slender, posterior projection curving slightly around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates rectangular and with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (104 μ) than wide (59 μ), with anterior end swollen, lateral margins diverging slightly posteriorly, posterior margin forming a point, and with three pairs of pre-anal setae and a pair of pores (Fig. 233). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (23 μ), the remainder short. One pair of long, slender metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with seven denticules and pilus dentilis; movable digit not seen. Legs normal, with three macrosetae on leg IV.

Male.—Ventrianal shield with three pairs of setae and a pair of pores in addition to para-anals. Movable digit of chelicera with lobed spermatophoral process.

Diagnosis.—Distinguished by the relative lengths of the lateral setae on the dorsal shield (setae L_2 and L_3 shorter than L_1 and L_4; L_5 half as long as L_6; L_7 and L_8 short), by setae L_9 and M_2 being serrated, and by the shape of the ventrianal shield.

Locality and Type Material.—The holotype, a female, and three additional females, collected from locust (*Robinia* sp.) at Beltsville, Maryland, October 11, 1950, by Dr. E. W. Baker, are in the United States National Museum. Four females and two males collected from black locust in Washington, D.C., July 4, 1953, are in the Canadian National Collection at the Belleville laboratory.

***T. (A.) leucophaeus* (Athias-Henriot) comb. n.**

Amblyseius leucophaeus Athias-Henriot, 1959: 139-144; Figs. 2, 3.

Syntypes deposited in Laboratoire d'Acarologia des Hautes Études, Paris.

Paratypes in École National d'Agriculture–Alger.

Dorsal shield reticulated and with 17 pairs of setae, nine in the lateral rows. All setae short. Seta L_7 nearly twice length of L_8. Sternal shield with two pairs of setae. Two pairs of metasternal plates. Peritreme short, not extending anterior of coxa II. Ventrianal shield irregular, generally vase shaped, and with three pairs of pre-anal setae and without pores. Three pairs of setae on membrane surrounding ventrianal shield. Two pairs metapodal plates. One small macroseta, on basitarsus IV. Athias-Henriot showed conclusively that the protonymph of this species has two dorsal shields. Type locality: *Thymelia hirsuta* (L.), Algeria.

***T. (A.) evansi* sp.n. (Figs. 234, 235)**

Female.–Length 338 μ; width 194 μ. Dorsal shield with faint reticulations, and with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 234). Setae L_1, L_4, L_9, and M_2 moderately long (32, 36, 59, and 45 μ respectively), remaining setae short or minute. Seta L_9 serrated, remaining setae smooth. Seta L_2 slightly shorter than L_3 (ratio approximately 6:7). Seta L_5 shorter than L_6. Seta L_7 twice length of L_8. Bases of setae L_7, L_8, and M_2 forming a triangle with approximately equal sides.

Setae S_1 and S_2 on interscutal membrane. Peritreme with hooked, posterior projection curving sharply around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (94 μ) than wide (63 μ), with anterior end bulbous, rounded, with lateral margins straight and diverging slightly posteriorly, and with three pairs of pre-anal setae and a pair of pores (Fig. 235). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (41 μ), the remainder short. Two pairs of metapodal plates, one large and rectangular, the other small and slender.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with eight strong teeth and pilus dentilis; movable digit with three distinct teeth. Legs normal, with three macrosetae on leg IV.

Male.–Unknown.

Diagnosis.–Distinguished by the relative lengths of the lateral setae on the dorsal shield and by the shape of the ventrianal shield.

Locality and Type Material.–The holotype and another female, collected from pepper at Isabella, Puerto Rico, January 5, 1951, by Mr. L. F. Martorell, are in the United States National Museum. Also in this collection is a female collected from lettuce imported from Mexico at Brownsville (Texas ?), April 7, 1937, by Mr. R. B. Haller. A fourth female, collected from Valencia oranges at Conway, Florida, February 26, 1954, by P. Norman, is in the Canadian National Collection at the Belleville laboratory. The species was named in honour of Dr. G. Owen Evans, British Museum (Natural History), London, England, who has worked extensively with the family Phytoseiidae.

***T. (A.) primulae* sp.n. (Figs. 236, 237)**

Female.–Length 322 μ; width 204 μ. Dorsal shield faintly sculptured, and with 17 pairs of setae, nine in the lateral, two in the median, and six in the dorsal rows (Fig. 236). Setal measurements as follows: L_1 29 μ; L_2 18 μ; L_3 23 μ; L_4

36 μ; L_5 16 μ; L_6 27 μ; L_9 59 μ; M_2 36 μ. Seta L_2 shorter than L_3; seta L_5 shorter than L_6. Seta L_7 short, L_8 minute. Remaining setae minute, except D_1. Bases of setae L_7 and M_2 closer to one another than to that of L_8. Setae L_9 and M_2 slightly serrated in some specimens.

Setae S_1 and S_2 on interscutal membrane. Peritreme broad, with short, slender, posterior projection curving slightly around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small and with a fourth pair of setae. Genital shield normal. Ventrianal shield longer (102 μ) than wide (68 μ), with lateral margins concave forming a distinct waist and then convex forming a bulge opposite anus, and with three pairs of pre-anal setae and a pair of distinct pores (Fig. 237). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (45 μ), remainder short. Two pairs of metapodal plates, one minute, the other long and slender.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera usually with seven denticules, and pilus dentilis; movable digit with one weak tooth. Legs normal, with three macrosetae on leg IV.

Male.—Ventrianal shield with three pairs of pre-anal setae and a pair of pores. Movable digit of chelicera with lobed spermatophoral process.

Diagnosis.—Distinguished by the relative lengths of setae L_2 and L_3, and L_5 and L_6 on the dorsal shield, and by the shape of the ventrianal shield.

Locality and Type Material.—The holotype, a female, three other females, two males, and two nymphs, collected from a leaf of the primrose family at Port Mayaca, Florida, March 18, 1953, by Mr. O. D. Link, are in the United States National Museum. One female collected from dog fennel at West Miami, Florida, February 12, 1953, by Mr. Link, is in the Canadian National Collection at the Belleville laboratory.

T. aberrans Group

Dorsal shield with 15 or 16 pairs of setae, seven or eight in the lateral rows. If with seven pairs of lateral setae, L_5 and L_7, or L_7 and L_8 absent, (Fig. 238); if with eight pairs of lateral setae, only L_7 absent (Fig. 240). Ventrianal shield much longer than broad, with lateral margins constricted anteriorly and forming a waist, with three pairs of pre-anal setae (Fig. 239).

Key to Species of *aberrans* Group

1. Eight pairs of lateral setae on dorsal shield ..... *T.* (*A.*) *aberrans* Oudemans
   Seven pairs of lateral setae on dorsal shield 2
2. Setae L_5 and L_7 absent ..... *T.* (*A.*) *oudemansi* sp.n.
   Setae L_7 and L_8 absent ..... *T.* (*A.*) *heveae* Oudemans

T. (A.) oudemansi sp.n. (Figs. 238, 239)

Female.—Length 275 μ; width 185 μ. Dorsal shield slightly reticulated, and having 14 pairs of setae, seven in the lateral, two in the median, and five in the dorsal rows (Fig. 238). Setae, D_5, L_5, and L_7 absent. Setae L_1 to L_4 slightly longer than distances between their bases. Setae L_9 and M_2 slightly serrated and long (54 and 45 μ respectively), remaining setae minute or short.

Setae S_1 and S_2 on interscutal membrane. Peritreme with slender, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with a fourth pair of setae. Genital shield normal. Ventrianal shield much longer (90 μ) than wide (54 μ), with lateral margins concave and forming a waist, and with three pairs of pre-anal setae (Fig. 239). Four pairs of setae on membrane surrounding ventrianal shield, one

(VL_1) serrated and moderately long (36 μ), the remainder smooth and short. One pair of long, slender metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with seven denticules and pilus dentilis; movable digit with two teeth. Legs normal, without specialized setae.

Male.—Unknown.

Diagnosis.—Resembling most closely *T. (A.) aberrans* but differing by having fewer setae on the dorsal shield, and in the shape of the ventrianal shield.

Locality and Type Material.—The holotype and two additional females, collected from *Rubus* sp. at the Field Station of the Belleville laboratory on August 27, 1956, are in the Canadian National Collection (No. 6862) at the Belleville laboratory. Three females with the same collection data are also in this collection. These specimens were collected by Mr. N. H. Anderson and myself. Seven females collected from grass at Cabin John, Maryland, May 7, 1951, by Dr. E. W. Baker, are in the United States National Museum. The species is named in honour of the late Dr. A. C. Oudemans, the Dutch acarologist who was an early worker with the family Phytoseiidae.

T. (A.) aberrans Oudemans (Figs. 240, 241)

Typhlodromus aberrans Oudemans, 1930: 48-49.
Typhlodromus vitis Oudemans, 1930: 99.
Typhlodromus elongatus Oudemans, 1930: 50.
Typhlodromus aberrans Oudemans, Nesbitt, 1951: 20-22; Plate I.
Typhlodromus vitis Oudemans, Nesbitt, 1951: 32; Plate VII.
Kampimodromus elongatus (Oudemans), Nesbitt, 1951: 53; Plate XXVII.
Typhlodromus aberrans Oudemans, Chant, 1955: 496-499; Fig. 1.
Amblyseius aberrans (Oudemans), Athias-Henriot, 1958: 36.
Typhlodromus aberrans Oudemans, Chant, 1958: 612, 615; Figs. 8, 20, 25.

Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 16 pairs of setae, eight in the lateral rows (Fig. 240). Seta L_3 slightly longer than L_2. Seta L_6 longer than L_5. No setae long and whiplike. Seta L_8 minute. Some lateral setae slightly serrated, particularly in overwintering females. Ventrianal shield longer than broad, with lateral margins constricted anteriorly and forming a slight waist, with three pairs of pre-anal setae (Fig. 241). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Legs without macrosetae. Collected in Europe, England, Canada, and the United States. Type locality: *Tilia* sp., Arnhem, The Netherlands.

The holotype of this species is a nymph. The immature stages of the Phytoseiidae are not well known and it is impossible at present to adequately characterize a species from only the nymph. The adult females used for the above description are: 26 females collected from hazel leaves, East Malling Research Station, Kent, England, in October, 1954, by myself.

T. (A.) heveae Oudemans (Figs. 242, 243)

Typhlodromus heveae Oudemans, 1930: 97.
Kampimodromus heveae (Oudemans), Nesbitt, 1951: 54; Plate XXIX.
Typhlodromus heveae Oudemans, Chant, 1955: 498.

Holotype in Rijksmuseum van Natuurlijke Historie, Leiden.

Dorsal shield with 14 pairs of serrated setae, seven in the lateral rows (Fig. 242). Seta D_5 absent. Seta L_3 longer than L_2; seta L_6 longer than L_5. Setae L_7 and L_8 absent. Setae S_1 and S_2 on interscutal membrane. Ventrianal shield rectangular, longer than wide, with three pairs of long pre-anal setae (Fig. 243).

Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with three macrosetae. Collected in Sumatra, only one specimen known. Type locality: *Hevea* sp. leaves, Medan, Sumatra. Oudemans' drawings (see Nesbitt, 1951) showed seta L_5 as part of the dorsal (D) series of setae and arising more mesad than is the case.

T. grandis Group

Dorsal shield with 15 pairs of setae, seven in the lateral rows. Setae L_7 and L_8 absent. Ventrianal shield semicircular in outline, with anterior margin straight, lateral and posterior margins convex, with three pairs of pre-anal setae and a pair of pores. There is only one known species.

T. (A.) grandis (Berlese) (Figs. 244, 245)

Amblyseius grandis Berlese, 1914: 144-145; Plate IV, Fig. 53.
Amblyseius grandis Berlese, Garman, 1948: 16; Fig. 8.
Amblyseius grandis Berlese, Cunliffe and Baker, 1953: 24; figures.
Typhlodromus grandis (Berlese), Chant, 1957a: 304; Figs. 29, 30.
Amblyseius grandis Berlese, Garman, 1958: 70-71; Fig. 1.

Lectotype in Berlese Collection, Florence (168/22) (Chant, 1957a).

Dorsal shield with 15 pairs of setae, seven in the lateral rows (Fig. 244). Setae L_7 and L_8 absent. Setae L_1, L_4, L_9, and M_2 very long. Remaining setae minute. Garman showed L_6 absent in his illustration but this is incorrect. Ventrianal shield reticulated, semicircular, wider than long, with anterior margin straight, lateral and posterior margins convex, with three pairs of pre-anal setae and a pair of pores (Fig. 245). Four pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates, one minute. Three macrosetae on leg IV. Collected in Argentina and the United States. Type locality: under tree bark, La Plata, Argentina. Probably a bark and soil inhabiting species.

T. sandersi Group

Dorsal shield with 15 pairs of setae, eight in the lateral rows and D_5 absent. Ventrianal shield triangular, broad, with three pairs of pre-anal setae.

Key to Species of *sandersi* Group

1. Seta L_6 absent; seta L_2 much longer than L_3 (Fig. 246) ..... *T. (A.) sandersi* sp.n.
   Seta L_5 absent; seta L_2 little if any longer than L_3 (Fig. 248) ..... *T. (A.) terrestris* sp.n.

T. (A.) sandersi sp.n. (Fig. 246)

Female.—Length 302 μ; width 239 μ. Dorsal shield heavily sclerotized, with 15 pairs of setae, eight in the lateral, two in the median, and five in the dorsal rows (Fig. 246). Setal measurements as follows: L_1 54 μ; L_2 32 μ; L_3 14 μ; L_4 81 μ; L_9 72 μ; M_2 99 μ. Remaining setae short or minute, except D_1. Setae D_5 and L_6 absent. Bases of setae L_7 and M_2 closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad, with extensions between coxae II, III, and IV, and with a very slender posterior projection curving partially around coxa IV. Remainder of ventral surface as in *T. (A.) fragariae*, described above (Fig. 189).

Gnathosoma and maxillary palps normal. Chelicera impossible to examine because of the position of the specimen. Legs normal, with three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by having setae L_6 and D_5 absent, by having L_2 shorter than L_1, and by the shape and character of the peritreme.

Locality and Type Material.—One female, collected from pineapple slips imported from the Dominican Republic at San Juan, Puerto Rico, September 16, 1955, by Mr. L. T. Sanders, is in the United States National Museum.

***T. (A.) terrestris* sp.n. (Figs. 247, 248)**

Female.—Length 334 μ; width 230 μ. Dorsal shield rugose, with 15 pairs of setae, eight in the lateral, two in the median, and five in the dorsal rows (Fig. 247). Setae L_5 and D_5 absent. Setae D_1, L_1, L_4, L_9, and M_2 moderately or very long (27, 32, 86, 199, and 126 μ respectively). Setae L_2, L_3, and L_6 minute, equal to one another. Remaining setae minute. Bases of setae M_2 and L_7 much closer to one another than to that of L_8.

Setae S_1 and S_2 on interscutal membrane. Peritreme very broad, with slender posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates small, with fourth pair of setae. Genital shield very broad, with posterior margin rounded. Ventrianal shield reticulated, as wide as long (94 μ), with anterior margin slightly concave, with lateral and posterior margins convex, and with three pairs of pre-anal setae (Fig. 248). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long (68 μ), the remainder short. Two pairs of long, slender, metapodal plates. Two additional long, slender plates on membrane between genital and ventrianal shields.

Gnathosoma and maxillary palps normal. Chelicera impossible to examine. Legs normal, with one macroseta on genu III, and three macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the chaetotaxy of the dorsal shield and by the shape and character of the ventrianal shield.

Locality and Type Material.—One female, collected from debris from the ground beneath apple trees at Kearneysville, West Virginia, February 8, 1954, by Dr. D. W. Clancy, is in the United States National Museum.

DUBIOUS SPECIES

***T. (A.) coronatus* (Fox) comb. n.**

Borinquolaelaps coronatus Fox, 1946: 450-451; Fig. 7.

***T. (A.) sexsetosus* (Fox) comb. n.**

Borinquolaelaps sexsetosus Fox, 1949: 39; Figs. 3A, B.

These species obviously belong to the subgenus *Amblyseius* but they cannot be specifically diagnosed from Fox's drawings or descriptions and I have not seen the type specimens. Both on *Rattus norvegicus*, Puerto Rico.

***T. (A.) hexagonus* (Berlese) comb. n.**

Amblyseius hexagonus Berlese, 1917: 173.

Berlese did not illustrate this species and his description is not sufficiently detailed for its identity to be determined. I have not seen the type specimen.

***T. communis* (Ribaga)**

Iphidulus communis Ribaga, 1902: 176.
Typhlodromus communis (Ribaga), Nesbitt, 1951: 33.

***T. communis* var. *hederae* (Ribaga)**

Iphidulus communis var. *hederae* Ribaga, 1902: 176.
Typhlodromus communis var. *hederae* (Ribaga), Nesbitt, 1951: 33.

***T. curtipilis* (Ribaga)**

Seiulus curtipilis Ribaga, 1902: 176.
Typhlodromus curtipilis (Ribaga), Nesbitt, 1951: 33.

Ribaga did not illustrate the above three taxa, his specimens seem to have been lost, and his descriptions are inadequate. Therefore, these taxa cannot be identified.

***T. musci* Oudemans**

Typhlodromus musci Oudemans, 1929: 31.

Oudemans described this species from the protonymph, and therefore it cannot be identified. His unpublished drawings, which I have examined, show that it probably belongs to the subgenus *Amblyseius* and that it may be based on the nymphs of a known species.

***T. (A.) hevearum* Oudemans**

Typhlodromus hevearum Oudemans, 1930: 97-98.
Kampimodromus hevearum (Oudemans), Nesbitt, 1951: 54-55; Plate XXX.

Oudemans described this species from one male collected in Sumatra. I have examined the type specimen and found Oudemans' drawings to be incorrect; the lateral setae are less distinctly serrated than he showed; seta L_3 is shorter than L_2; seta L_5 is not on the edge of the dorsal shield but is set in about three times its own length; seta S_2 is minute and located where L_5 is shown in Oudemans' drawing; and the final pair of setae on the sternal shield is very strong. The male is definitely not that of *T. heveae* because in one species D_5 is absent and in the other it is present. The exact identity of this species cannot be determined; probably the female has not yet been described.

***T. tiliacolis* Oudemans**

Typhlodromus tiliacolis Oudemans, 1929: 33-34.
Typhlodromus tiliacolis Oudemans, Nesbitt, 1951: 40-41; Plates XVI, XVII.

Oudemans described this species from the male and its identity cannot be determined. The male seems to have 12 pairs of lateral setae on the dorsal shield and the female as illustrated, but not described, has nine pairs. Two species may be involved but because Oudemans himself stated that the male was very close to *T.* (*A.*) *finlandicus* his drawings of the male probably are incorrect; he seems to have included setae S_1 and S_2 on the dorsal shield in the lateral series, and he may also have included a seta from the coxae or other ventral surfaces. If these three suspect setae are ignored, the arrangement of setae is typical, of the subgenus *Amblyseius*.

***T. vepallidus* (Koch)**

Gamasus vepallidus Koch, 1839: Fasc. 25; Fig. 22.
Typhlodromus vepallidus (Koch), Vitzthum, 1941: 767.
Typhlodromus vepallidus (Koch), Nesbitt, 1951: 42.

This mite cannot be identified from Koch's descriptions. Nesbitt states that it may be very close to, or synonymous with, *T.* (*T.*) *rhenanus* but he admits that the evidence for this is circumstantial and is based solely on the fact that Koch described his species from elm leaves and that *T. rhenanus* is frequently found on this tree. Vitzthum believed it to be the type of the genus *Typhlodromus* and synonymous with *T. pyri* but Nesbitt disposed of this argument.

***T. polonicus* (Willmann)**

Lasioseius polonicus Willmann, 1949: 117-118; Figs. 14, 15.
Typhlodromus polonicus (Willmann), Chant, 1956: 26, 32.

Willmann's drawings of this species show it to have 10 pairs of lateral setae on the dorsal shield, but the drawing is poor and the reproduction so small that it is difficult to be certain of this. Dr. G. Owen Evans (*in litt.*) and I are of the opinion that the other features shown indicate that this species has really only

nine pairs of lateral setae and that it belongs to the subgenus *Amblyseius*. Dr. Evans collected a mite in the grounds of the British Museum (Natural History) that he considers to be *T. polonicus* but I have not studied this in detail and it is not illustrated in this paper. The mite collected by Dr. Evans is very close to *T.* (*A.*) *cucumeris* and *T.* (*A.*) *marinus* in that the setae on the dorsal shield are very short and the ventrianal shield is triangular with three pairs of pre-anal setae (in agreement with Willmann's drawings), but the status of *T. polonicus* cannot be determined until Willmann's type specimens have been re-examined.

***T.* (*A.*) *alpinus* (Schweizer) comb. n.**

Amblyseius alpinus Schweizer, 1922: 33: 23-112; 1 fig.
Amblyseius obtusus alpinus Schweizer, Cooreman, 1943: 25; Plate IV, Fig. 6.
Amblyseius alpinus Schweizer, Schweizer, 1949: 79; Fig. 50, a and b.

This mite cannot be identified from the drawings and descriptions that I have seen, and I have not examined the type specimen. Schweizer's and Cooreman's drawings show it to be of the subgenus *Amblyseius;* it seems to be very close to *T.* (*A.*) *obtusus*.

***T.* (*A.*) *magnanalis* (Thor) comb. n.**

Lasioseius magnanalis Thor, 1930: 109-111; Plate 18, Fig. 74.

Thor illustrated only the ventral surface of this species but this is sufficient to show that this species should be placed in the family Phytoseiidae, subgenus *Amblyseius*. Its identity cannot be determined from his description.

***T.* (*A.*) *setatus* (Berlese) comb. n.**

Amblyseius setatus Berlese, 1917b: 305.

Berlese did not illustrate this species and its identity cannot be determined from his description.

Genus Phytoseius Ribaga

Phytoseius gen. n. Ribaga, 1902: 177.
Type species by original designation: *Gamasus plumifer* Canestrini and Fanzago, 1876.

Diagnosis.—This genus is distinguished by having thickened, long, very strongly serrated setae on the dorsal shield, by a reduction in the number of lateral setae present, and by having seta S_1 on the dorsal shield associated with setae L_4 and L_5 instead of on the interscutal membrane. In a recent paper, Wainstein (1959) separated the genus into two subgenera but in light of the new species described below, *P. platypilis* sp.n., his characters for separation must be modified. He separated his subgenera on the fact that *P. plumifer* has both setae D_5 and S_2 present, whereas in the remaining known species both are absent. In *P. platypilis* sp.n., however, seta D_5 is present though S_2 is absent. I therefore consider the mere presence or absence of S_2 to separate the two subgenera.

Key to Subgenera of the Genus *Phytoseius*

1. Seta S_2 present, on interscutal membrane ..... *Phytoseius* s. str.
   Seta S_2 absent ..... *Dubininellus* Wainstein

Subgenus Phytoseius Ribaga

Phytoseius sub.gen.n., Wainstein, 1959: 1362.
Type species by original designation: *Phytoseius* (*Phytoseius*) *plumifer* (Canestrini and Fanzago).

Diagnosis.—This subgenus is characterized by having setae D_5 and S_2 present, with the latter on the interscutal membrane. A second species can be added to the one included by Wainstein in the subgenus.

Key to Species of the Subgenus *Phytoseius*

1. Lateral setae short; L_5 about as long as distance between its base and that of L_6; a large pore associated with seta M_1 ..... *P. (P.) nahautlensis* De Leon
   Lateral setae longer; L_5 longer than distance between its base and that of L_6; without large pore associated with seta M_1 ..... *P. (P.) plumifer* (Canestrini and Fanzago)

P. (P.) nahautlensis De Leon

Phytoseius nahautlensis De Leon, 1959: 147-148; Figs. 3, 4.

Holotype in De Leon's personal collection, Pensacola, North Carolina. Paratypes in University of Florida Collection, Gainesville.

Dorsal shield with 16 pairs of setae, seven in the lateral rows. Seta S_1 on dorsal shield associated with L_4. Seta D_5 present. All lateral setae, S_1, and M_2 somewhat thickened, thornlike, and serrated. Seta L_1 about as long as distance between its base and that of L_2. Seta L_5 about as long as distance between its base and that of L_6. A pair of large, conspicuous pores associated with setae M_1. Ventrianal shield as in *P. (P.) plumifer*. Leg IV with three macrosetae, genu, tibia, and basitarsus. Collected on a variety of plants in Mexico and Central America. Type locality: "*Lonchocarpus rugosus*", Tuxtla Gutierrez, Chiapas, Mexico.

P. (P.) plumifer (Canestrini and Fanzago) (Figs. 249, 250)

Gamasus plumifer Canestrini and Fanzago, 1876: 130-142.
Phytoseius plumifer (Canestrini and Fanzago), Ribaga, 1902: 177.
Phytoseius plumifer (Canestrini and Fanzago), Nesbitt, 1951: 56.
Phytoseius plumifer (Canestrini and Fanzago), Athias-Henriot, 1957a: 342; Fig. 5C.
Phytoseius plumifer (Canestrini and Fanzago), Chant, 1957d: 362-363; Figs. 9-11.
Phytoseius (P.) plumifer (Canestrini and Fanzago), Wainstein, 1959: 1365.

Holotype in Ribaga's collection, Portici (?).

Dorsal shield with 16 pairs of setae, seven in the lateral rows (Fig. 249). Seta S_1 on dorsal shield associated with setae L_4 and L_5. Seta D_5 present. All lateral setae, S_1, and M_2 thickened, thornlike, and strongly serrated. Seta L_1 much longer than distance between its base and that of L_2. Seta L_5 longer than distance between its base and that of L_6. Ventrianal shield long, with lateral margins constricted and with three pairs of pre-anal setae (Fig. 250). Three pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Leg IV with one macroseta. Collected from Italy and California on grape vines. Type locality: Italy. A thorough search for the holotype has not been made.

SUBGENUS DUBININELLUS WAINSTEIN

Dubininellus sub. gen. n. Wainstein, 1959: 1362.

Type species by original designation: *Phytoseius* (*Dubininellus*) *corniger* Wainstein, 1959.

Diagnosis.—This subgenus is characterized by having seta S_2 absent. Seta D_5 is absent in all but one species. There are two known species and two more are herein described.

Key to Species of the Subgenus *Dubininellus*

1. Without visible macrosetae on genu IV 2
   Genu IV with one macroseta 3
2. With two or three pairs of pre-anal setae on ventrianal shield ..... *P. (D.) corniger* Wainstein
   With one pair of pre-anal setae on ventrianal shield (Fig. 256) ..... *P. (D.) bakeri* sp.n.
3. Seta D_5 present (Fig. 253) ..... *P. (D.) platypilis* sp.n.
   Seta D_5 absent (Fig. 251) ..... *P. (D.) macropilis* (Banks)

***P. (D.) corniger* Wainstein**

Phytoseius (Dubininellus) corniger Wainstein, 1959: 1362-1364; Plates I-IV.

Holotype in the collections of the Republic Station of Plant Protection, Kazackh Branch of the All-Union V.I. Lenin Academy of Agricultural Sciences, U.S.S.R. (?).

Dorsal shield with 15 pairs of setae, seven in the lateral rows. Seta S_1 on dorsal shield associated with setae L_4 and L_5. All lateral setae, S_1, and M_2 thickened, thornlike, and strongly serrated. Setae D_5 and S_2 absent. Ventrianal shield long, with lateral margins constricted, and with two or three pairs of pre-anal setae. One pair of metapodal plates. Leg IV with two macrosetae, tibia and basitarsus. Collected in U.S.S.R.

***P. (D.) macropilis* Banks (Figs. 251, 252)**

Sejus macropilis Banks, 1909: 135; Fig. 16.
Seiulus spoofi Oudemans, 1915a: 184. (Type locality: *Salix* sp., Åbo, Finland.)
Seiulus spoofi Oudemans, Oudemans, 1915b: 161-165; Figs. 120-127.
Typhlodromus spoofi (Oudemans), Oudemans, 1930: 98-99.
Phytoseius spoofi (Oudemans), Nesbitt, 1951: 57, Plates XXXI, XXXII.
Phytoseius macropilis (Banks), Cunliffe and Baker, 1953: 22; figures.
Phytoseius macropilis (Banks), Nesbitt, 1954: 24.
Phytoseius macropilis (Banks), Womersley, 1954: 187-188; Fig. 11.
Phytoseius macropilis (Banks), Chant, 1957d: 362.
Phytoseius macropilis (Banks), Chant, 1958: 633, 635; Figs. 17, 26.
Phytoseius (D.) macropilis (Banks), Wainstein, 1959: 1365.

Holotype in United States National Museum.

Dorsal shield with 15 pairs of setae, seven in the lateral rows (Fig. 251). Seta S_1 on dorsal shield associated with setae L_4 and L_5 instead of on interscutal membrane. All lateral setae, S_1, and M_2 thickened, thornlike, strongly serrated, and mostly very long. Seta D_5 absent. Ventrianal shield very long, with lateral margins constricted, and with two or three pairs of pre-anal setae (the number is variable), and there may be two on one side and three on the other (Fig. 252). Three or four setae (depending on the number on the ventrianal shield – if there are three on the latter, then there are only three on the membrane) on membrane surrounding ventrianal shield. One pair of metapodal plates. Leg IV with three macrosetae. Collected in Europe, England, Canada, the United States, India, Russia, Australia, and the British West Indies. Type locality: aspen, Guelph, Ontario.

***P. (D.) platypilis* sp.n. (Figs. 253, 254, 255)**

Female.—Length 257 μ; width 149 μ. Dorsal shield faintly reticulated, with 15 pairs of setae, six in the lateral, two in the median, and six in the dorsal rows (Fig. 253). Seta S_1 on dorsal shield. Setae D_1, L_1, L_4, L_5, L_6, M_2, and S_1 strongly serrated, long (32, 50, 99, 72, 81, 72, and 50 μ respectively), very broad and flattened (seta L_4 is 18 μ wide). Remaining setae minute.

Seta S_2 absent. Peritreme with slender posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates with fourth pair of setae. Genital shield normal. Ventrianal shield much longer (77 μ) than wide (36 μ), with lateral margins constricted, posterior margin rounded, and with two pairs of pre-anal setae (Fig. 254). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) serrated, flattened, and moderately long (50 μ). One pair of long, slender, metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with two teeth and pilus dentilis; movable digit with one weak tooth. Legs with setae mostly short or minute; leg IV with three thick, lobed, macrosetae (Fig. 255).

Male.—Unknown.

Diagnosis.—Differing from other species in the genus by having a different number of setae on the dorsal shield, and by having some setae on the shield not only very serrated and long but also distinctly flattened.

Locality and Type Material.—The holotype and another female, collected from lantana at Coral Gables, Florida, February 17, 1953, by Mr. O. D. Link, are in the United States National Museum.

***P. (D.) bakeri* sp.n. (Fig. 256)**

Female.—Length 284 μ; width 147 μ. Dorsal shield as in *P. macropilis*. Ventral surface as in *macropilis* except: ventrianal shield approximately rectangular with anterior end narrow, longer (78 μ) than wide (45 μ), and with one pair of pre-anal setae (Fig. 256). Five pairs of setae on membrane surrounding ventrianal shield, one (VL_1) long, thickened, and serrated, the remainder short.

Gnathosoma and maxillary palps normal. Legs I to III short; leg IV long and with one long, thickened macroseta on tibia.

Male.—Ventrianal shield with three pairs of pre-anal setae. Chelicera with spermatophoral process.

Diagnosis.—This species is separated from others of the genus by having only one pair of pre-anal setae on the ventrianal shield. As mentioned above, in *P. macropilis* the number is variable and, rarely, I have seen specimens with only one pair. However, more than 50 specimens of the new species have been examined and on all but one only a single pair of these setae was found; one specimen had two setae on one side of the shield and one on the other. The shape and size of the single macroseta on leg IV is distinctive.

Locality and Type Material.—The holotype, a female, and 32 additional females and three males, collected from "plant XY" at St. Petersburg, Florida, July 11, 1952, by Dr. E. W. Baker, who was aided by a grant from the Pinellas Biological Laboratory, Inc., are in the United States National Museum. Female specimens from willow, St. Petersburg, July 12, 1952, are in the Canadian National Collection at the Belleville laboratory. The species is named in honour of Dr. Baker.

DUBIOUS SPECIES

***P. finitimus* Ribaga**

Phytoseius finitimus Ribaga, 1902: 178.
Phytoseius finitimus R baga, Nesbitt, 1951: 58.
Phytoseius (D.) finitimus Ribaga, Wainstein, 1959: 1365.

***P. horridus* Ribaga**

Phytoseius finitimus Ribaga, 1902: 178.
Phytoseius horridus Ribaga, Nesbitt, 1951: 58.

Ribaga's descriptions of these two species are too vague and general for them to be adequately characterized or identified. His descriptions of the two are almost identical with each other.

GENUS PHYTOSEIULUS EVANS

Phytoseiulus gen. n. Evans, 1952b: 397.

Type species, by monotypy: *Laelaps macropilis* Banks, 1904.

Diagnosis.—Dorsal shield with 14 pairs of simple or slightly serrated setae.

Seta D_5 absent and D_4 and L_4 longer than other dorsal setae. Ventrianal shield without pre-anal setae or with one pair of pre-anal setae. This genus is known only from the tropics and subtropics.

Key to Species of the Genus *Phytoseiulus*

1. Ventrianal shield without pre-anal setae (Fig. 286) ..... *P. persimilis* Athias-Henriot
   Ventrianal shield with one pair of pre-anal setae (Fig. 258) ..... *P. macropilis* (Banks)

Phytoseiulus persimilis Athias-Henriot (Figs. 285, 286)

Phytoseiulus persimilis Athias-Henriot, 1957a: 347-348; Fig. 7.
Phytoseiulus riegeli Dosse, 1958a: 48-55; Figs. 6-10. *New synonymy*. (Type locality: Stuttgart, from Chile).
Phytoseiulus riegeli Dosse, Dosse, 1958b: 9; Fig. 15.
Phytoseiulus persimilis Athias-Henriot, Athias-Henriot, 1959: 148.
Phytoseiulus riegeli Dosse, Athias-Henriot, 1959: 148.

Holotype in Muséum National d'Histoire Naturelle, Paris, France.

Dorsal shield (Fig. 285) with 14 pairs of setae, seven in lateral rows. Setae L_1, L_3, L_4, L_5, L_7, M_2, D_2, D_3, D_5 long, slender, serrated. Setae M_1, L_2, D_5 minute. Seta L_6 short, smooth. Setae S_1 and S_2 on interscutal membrane. Sternal shield with three pairs of setae, fourth pair on metasternal plates. Genital shield long. Ventrianal shield without pre-anal setae. Five pairs of setae on membrane surrounding anal plate. Two pairs metapodal plates. Two small platelets between ventrianal and genital shields. Collected in Algeria and Chile. Type locality: Staouéli, Algeria. I can find no major differences between Dosse's species (of which I have specimens) and *P. persimilis* and provisionally consider it a synonym of the latter. The coxal glands are very similar.

Phytoseiulus macropilis (Banks) (Figs. 257, 258)

Laelaps macropilis Banks, 1905: 139.
Hypoaspis macropilis (Banks), Banks, 1915: 85; Fig. 169.
Hypoaspis macropilis (Banks), Smith and Summers, 1949: 209-218; 2 plates.
Phytoseiulus speyeri Evans, 1952: 397-401; Figs. 1-3. (Type locality: tomato plants, Canary Islands.)
Phytoseiulus macropilis (Banks), Cunliffe and Baker, 1953: 23; figures.
Phytoseiulus macropilis [sic], Garman, 1958: 70.
Phytoseiulus macropilis (Banks), Kennett, 1959: 477-478.
Phytoseiulus macropilis Banks [sic], Athias-Henriot, 1959: 148.

Holotype in United States National Museum.

I have examined both Banks' and Evans' types and found that *P. speyeri* is synonymous with *P macropilis*. Dorsal shield with 14 pairs of setae, seven in the lateral rows (Fig. 257). Setae L_1, L_3, L_4, L_5, L_7, D_2, D_3, D_4, and M_2 long or very long, and mostly serrated. Seta D_5 absent. Ventrianal shield almost square, with one pair of pre-anal setae (Fig. 258). Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with two macrosetae. Collected in the United States, the British West Indies, Hawaii, the Canary Islands, and the Panama Canal Zone. Type locality: water hyacinth, Eustis, Florida.

Genus Iphiseius Berlese

Iphiseius Berlese, 1916: 33, nomen nudum.
Iphiseius Berlese, Berlese, 1921: 95.
Iphiseius Berlese, Vitzthum, 1941: 764-765.
Iphiseius Berlese, Evans, 1954: 517-524.

Type species, by monotypy: *Seius degenerans* Berlese, 1889.

Diagnosis.—Interscutal membrane sclerotized and fused with dorsal shield.

Key to Species of the Genus *Iphiseius*

1. All setae on dorsal shield minute (Fig. 259) ..... *I. degenerans* (Berlese)
   Some setae on dorsal shield long 2
2. Setae L_6 and L_7 absent; seta L_1 short, L_2 and L_3 minute and equal to one another (Fig. 261) ..... *I. quadripilis* (Banks)
   Setae L_5 and L_6 absent; seta L_1 moderately long; L_2 (short) longer than L_3 (minute) (Fig. 263) ..... *I. grovesae* sp.n.

***I. degenerans* (Berlese) (Figs. 259, 260)**

Seius degenerans Berlese, 1889: 9; figures.
Iphiseius degenerans (Berlese), Berlese, 1921: 95.
Iphiseius degenerans (Berlese), Evans, 1954: 517-524; Figs. 1-10.
Iphiseius degenerans (Berlese), Athias-Henriot, 1957a: 335-336; Fig. 3B.

Holotype in Berlese Collection, Florence.

Dorsal shield with 14 pairs of setae, nine in the lateral rows (Fig. 259). All setae minute except D_1. Interscutal membrane sclerotized, with two pairs of setae, S_1, and S_2. Ventrianal shield fragmented into two shields, the anal and the ventral (Fig. 260). Anal shield with three setae. Ventral shield with three pairs of setae and a pair of pores. Four pairs of setae on membrane surrounding ventral and anal shields. Two pairs of metapodal plates. Leg IV with three macrosetae. Collected in Portugal, Italy, Israel, Algeria, and Tanganyika. Type locality: on leaves and moss, Italy.

***I. quadripilis* (Banks) comb. n. (Figs. 261, 262)**

Sejus quadripilis Banks, 1904: Fig. 104.
Seiulus quadripilis Banks, Banks, 1905: 138.
Seiulus quadripilis Banks, Banks, 1915: 85; Fig. 167.
Amblyseius quadripilis (Banks), Cunliffe and Baker, 1953: 26; figures.
Amblyseiulus quadripilis Banks [sic], Garman, 1958: 71, Fig. 2.

Holotype in United States National Museum.

Dorsal shield with 14 pairs of setae, seven in the lateral rows (Fig. 261). Setae L_6, L_7, and D_5 absent. Setae L_4 and L_9 long. Remaining setae minute. Ventrianal shield triangular, wider than long, with three pairs of pre-anal setae and a pair of pores (Fig. 262). Three pairs of setae on membrane surrounding ventrianal shield, a fourth pair on sclerotized extension of dorsal shield. Two pairs of metapodal plates. Another small plate on membrane between ventrianal shield and metapodal plates. Legs without macrosetae. Collected in Mexico, the United States, and the British West Indies. Type locality: citrus, Florida.

***I. grovesae* sp.n. (Figs. 263, 264)**

Female.—Length 320 μ; width 208 μ. Dorsal shield smooth, with 14 pairs of setae, seven in the lateral rows (Fig. 263). Setae L_5, L_6, and D_5 absent. Setae L_1, L_4, L_9, and M_2 long (32, 72, 117, and 104 μ respectively). Seta L_3 shorter than L_2, both short. Remaining setae minute, except D_1. Bases of setae L_7 and M_2 closer to one another than to base of L_8.

Setae S_1 and S_2 on partially sclerotized interscutal membrane. Peritreme broad, with very slender, slightly hooked, posterior projection curving around base of coxa IV. Sternal shield normal, with three pairs of setae. Metasternal plates oval, with a fourth pair of setae. Genital shield normal. Ventrianal shield wider (99 μ) than long (90 μ), nearly triangular, slightly reticulated, and with three pairs of pre-anal setae (Fig. 264). Four pairs of setae on membrane surrounding ventrianal shield, one (VL_1) of moderate length (54 μ), the remainder short. Two pairs of metapodal plates.

Gnathosoma and maxillary palps normal. Fixed digit of chelicera with eight minute denticules and pilus dentilis; movable digit with one small tooth. Legs normal, with one macroseta on leg III (genu) and three stout macrosetae on leg IV.

Male.—Unknown.

Diagnosis.—Distinguished by the absence of setae L_5, L_6, and D_5, by the relative lengths of setae L_2 and L_3, and by the shape of the ventrianal shield.

Locality and Type Material.—One female, collected from moss at East Malling, Kent, England, November 12, 1948, by Dr. Joan R. Llewellyn (née Groves), is in the Canadian National Collection (No. 6864) at the Belleville laboratory.

Genus Asperoseius Chant

Asperoseius gen.n., Chant, 1957d: 360.
Asperoseius Chant, Athias-Henriot, 1958: 26.

Type species by monotypy: *Asperoseius africanus* Chant, 1957.

This genus is characterized by having the seven lateral setae flattened and serrated. There is only one known species.

A. africanus Chant (Figs. 265, 266)

Asperoseius africanus Chant, 1957d: 360, 362; Figs. 6-8.

Holotype in United States National Museum.

Dorsal shield with 14 pairs of setae (Fig. 265). Lateral setae, D_1, D_4, and M_2 serrated and slightly flattened. Seta D_5 absent. Seta L_7 the only lateral seta on posterior third of body. Seta D_4 longer than other dorsal (D) setae. One pair of metasternal plates. Two pairs of metapodal plates. Ventrianal shield oblong, with three pairs of pre-anal setae (Fig. 266). Shield creased posterior to anus. Two pairs of setae on membrane surrounding ventrianal shield. Legs without macrosetae. Collected from South Africa. Type locality: cut flowers from South Africa at Boston, Massachusetts.

Genus Proprioseius Chant

***Proprioseius* gen.n., Chant, 1957d: 357-358.**

Proprioseius Chant, Athias-Henriot, 1958: 26.
Proprioseius Chant, De Leon, 1959: 147.

Type species by original desgination. *Proprioseius meridionalis* Chant, 1957.

Diagnosis.—Dorsal shield with 14 pairs of setae, only seven pairs of lateral setae. Seta D_5 absent. Setae on dorsal shield strongly serrated, slightly club-shaped. Ventrianal shield with three pairs of pre-anal setae.

Key to Species of Genus *Proprioseius*

1. Seta L_3 much shorter than L_2; ventrianal shield without conspicuous waist (Fig. 268) ..... *P. meridionalis* Chant
   Seta L_2 and L_3 nearly equal in length, short; ventrianal shield with distinct waist (Fig. 270) 2
2. Setae L_1 to L_4 short, L_4 only slightly longer than L_3 (Fig. 269) ..... *P. clancyi* Chant
   Setae L_1 to L_3 short, L_4 much longer than L_3 ..... *P. mirandai* De Leon

P. meridionalis Chant (Figs. 267, 268)

Proprioseius meridionalis Chant, 1957d: 358; Figs. 1-3.
Proprioseius meridionalis Chant, De Leon, 1959: 149.

Holotype in United States National Museum.

Dorsal shield with 14 pairs of setae, seven in the lateral rows (Fig. 267). The longer setae strongly serrated and club-shaped. Setae L_3, L_5, and L_6 short,

not strongly serrated. Seta D_5 absent. Two pairs of metapodal plates. Ventrianal shield rectangular, with lateral margins slightly constricted, with three pairs of pre-anal setae (Fig. 268). Four pairs of setae on membrane surrounding ventrianal shield. Collected only in Florida. Type locality: *Psychotria* sp., Homestead, Florida.

P. clancyi Chant (Figs. 269, 270)

Proprioseius clancyi Chant, 1957d: 358, 360; Figs. 4, 5.
Proprioseius clancyi Chant, De Leon, 1959: 149.

Holotype in United States National Museum.

Dorsal shield with 14 pairs of setae, seven in the lateral rows (Fig. 269). Setae M_2 and L_7 long; remaining lateral setae short, strongly serrated, club-shaped. Seta D_5 absent. One pair of metapodal plates. Ventrianal shield rectangular, with lateral margins constricted, with three pairs of pre-anal setae (Fig. 270). Four pairs of setae on membrane surrounding ventrianal shield. Collected in West Virginia. Type locality: *Rubus* sp., Kearneysville, West Virginia.

P. mirandai De Leon

Proprioseius mirandai De Leon, 1959: 149-150; Figs. 1-2.

Holotype in De Leon's personal collection, Pensacola, North Carolina: paratypes in the University of Florida Collection, Gainesville.

Dorsal shield with 14 pairs of setae, seven in the lateral rows. Setae L_4, L_7, and M_2 very long, slightly serrated. Remaining setae short or minute. Seta D_5 absent. Two pairs of metapodal plates. Ventrianal shield with a distinct waist and with three pairs of setae. Four pairs of setae on membrane surrounding ventrianal shield. Leg IV with one macroseta, basitarsus. Collected in Mexico. Type locality: from "*Lippia umbellata*", Tepic, "Nay.", Mexico.

Genus Seiulus Berlese

Seiulus gen. n., Berlese, 1887: 3.
Echinoseius Ribaga, 1902: 177.
Neoseiulus Hughes, 1948: 141. (Type species by original designation *N. barkeri* Hughes.)

Type species by monotypy: *Seius* (*Seiulus*) *hirsutigenus* Berlese, 1887.

Diagnosis.—Dorsal shield with 17 or more pairs of setae, with seven or 11 in lateral rows; if the former, then more than two pairs in median rows. Lateral setae either thick, thorn-like, smooth, or much serrated. Ventrianal shield with one or two pairs of pre-anal setae. The type species, known only from Berlese's drawings of the nymph, may properly belong in the Aceosejidae as defined by Evans (1957). If so, both *S. simplex* and *S. isotrichus* will remain in the Phytoseiidae and it will be necessary to erect a new genus for them.

Key to Species of Genus *Seiulus*

1. Eleven pairs of lateral setae on dorsal shield; setae on dorsum thick, thornlike, smooth ..... *S. simplex* Chant
   Seven pairs of lateral setae on dorsal shield; setae on dorsum of normal thickness, very serrated ..... *S. isotrichus* Athias-Henriot

S. simplex Chant (Figs. 271, 272)

Seiulus simplex Chant, 1956: 32-34; Figs. 3, 4.
Seiulus simplex Chant, Chant, 1958: 635-636; Figs. 18, 23, 26.

Holotype in British Museum (Natural History).

Dorsal shield with 19 pairs of setae, 11 in the lateral rows (Fig. 271). Lateral setae except L_{10}, D_5, M_2 thickened, thornlike, not serrated. Setae D_2 to D_4, M_1, and L_{10} minute. Setae S_1 and S_2 on interscutal membrane. Sternal shield with two pairs of setae. Two pairs of metasternal plates, each with a pair

of setae. Genital shield broad, truncate, with a pair of setae. Ventrianal shield oblong, with one pair of pre-anal setae (Fig. 272). Six pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. Legs without macrosetae. Common on oak and beach in southeastern England. Type locality: bark of *Fagus* sp., Barming Heath, Kent, England.

***S. isotrichus* Athias-Henriot (Figs. 283, 284)**

Seiulus isotrichus Athias-Henriot, 1958: 37-39; Fig. 9.

Syntypes in Muséum d'Histoire Naturelle, Paris, France.

Dorsal shield (Fig. 283) with 17 pairs of setae, seven in lateral rows, four in median rows, six in dorsal rows. All setae short, approximately equal, serrated. Sternal shield with two pairs of setae, third and fourth pairs on metasternal plates. Genital shield long. Ventrianal shield longer than wide, vase-shaped (Fig. 284), constricted anteriorly, and with two pairs of pre-anal setae. Six pairs of setae on membrane surrounding ventrianal shield. Two pairs of metapodal plates. A long narrow platelet between ventrianal and genital shields. Legs without macrosetae. Collected only in Algeria. Type locality: *Inula* sp., Resauta, Algeria.

DUBIOUS SPECIES

***S. hirsutigenus* Berlese**

Seius (Seiulus) hirsutigenus Berlese, 1887: Fasc. 41, N3.
Seiulus hirsutigenus Berlese, Nesbitt, 1951: 9-11.

Holotype (nymph) in Berlese Collection, Florence.

Berlese described this species from an immature form and its identity cannot be determined.

Genus Typhloseiopsis De Leon

Typhloseiopsis gen. n. De Leon, 1959: 150.

Type species by original designation: *Typhloseiopsis theodoliticus* De Leon, 1959.

Diagnosis.—This genus is characterized by having five pairs of anterolateral setae and by having only an anal plate in the female. The male has a fragmented ventrianal shield. There is only one species.

***T. theodoliticus* De Leon**

Typhloseiopsis theodoliticus De Leon, 1959: 150-152; Figs. 5-9.

Holotype in De Leon's personal collection, Pensacola, North Carolina.
Paratypes in the University of Florida Collection, Gainesville.

Dorsal shield with 16 pairs of setae, eight in the lateral rows. Setae L_1, L_4, and L_8 longer than remaining setae, which are short or minute. Setae S_1 and S_2 on interscutal membrane. Four pairs of pre-anal setae and a pair of pores on membrane anterior to anal plate. Three pairs of setae on membrane surrounding ventrianal area. Two pairs of metapodal plates. Genu I to IV, and tibia and basitarsus IV with macrosetae. Collected in Mexico. Type locality: from "*Paullinia fuscescens*", San Blas, "Nay.", Mexico.

Subfamily Macroseiinae Chant, Denmark and Baker

This subfamily is characterized by having the dorsal shield divided into nearly equal anterior and posterior shields. It contains but one genus.

Genus Macroseius Chant, Denmark and Baker

Macroseius gen. n. Chant, Denmark, and Baker, 1959: 808-811.

Type species by monotypy: *Macroseius biscutatus* Chant, Denmark, and Baker, 1959.

Diagnosis.—This genus is characterized by having seta S_1 on the anterior dorsal shield and S_2 on the interscutal membrane near the posterior margin of the anterior shield. The ventrianal shield has one pair of preanal setae.

***M. biscutatus* Chant, Denmark, and Baker**

Macroseius biscutatus Chant, Denmark and Baker, 1959: 808-811; Figs. 1-10.

Holotype in Canadian National Collection (No. 7053).

Dorsal shield subdivided into anterior and posterior shields. Anterior shield with 10 pairs of setae, four in the lateral rows. Setae D_1 to D_4, M_1 minute. Seta S_1 on anterior shield. Posterior shield with nine pairs of setae, five in the lateral rows. Setae L_5, L_8, D_5 to D_7 minute. Setae L_7, L_9, and M_2 slightly serrated. Ventrianal shield with one pair of preanal setae. Six pairs of setae on membrane surrounding ventrianal shield. Two pairs metapodal plates. Genu III and IV, and femur, tibia, and basitarsus IV with macrosetae. Collected in Florida. Type locality: from *Sarracenia* sp., Alachua Co., Florida.

ACKNOWLEDGMENTS

Part I of this investigation was done while I was a student at the East Malling Research Station, Kent, England, under the direction of Dr. A. M. Massee, who gave generously of his encouragement and advice throughout. I am indebted to Dr. R. S. Pitcher, Dr. Elsie Collyer, Mr. R. C. Muir, and to other members of the Entomology Section at East Malling for their assistance and advice, and to Mr. G. H. Freeman, of the Statistics Section, for his help with the statistical analyses.

While the investigation reported in Part I was in progress I was on educational leave from the Entomology Division, Canada Department of Agriculture, and for the year 1953-54 was in receipt of a Special Scholarship for Overseas Study granted by the National Research Council of Canada; both are gratefully acknowledged.

I also wish to thank Dr. G. Owen Evans of the British Museum (Natural History) for his assistance with Part I of this paper, and Mr. J. H. McLeod of the Entomology Laboratory, Belleville, Ont., who helped me in many material ways.

For help with the study reported in Part II, I am indebted to Dr. G. Owen Evans, to Dr. Van der Hammen, Rijksmuseum van Natuurlijke Historie, Leiden, Dr. A. Melis, Stazione di Entomologia Agraria, Florence, Dr. H. H. J. Nesbitt, Carleton University, Ottawa, Dr. P. Garman, New Haven, Connecticut, and Dr. Edward W. Baker, United States Department of Agriculture, Washington, D.C., for permission to inspect the collections at these institutions. I am also very grateful to Dr. Baker for permission to borrow from and to study the phytoseiid collection of the United States National Museum and because he spent several days checking the keys contained in this paper. Mr. N. H. Anderson of the Belleville laboratory, and Mr. C. V. G. Morgan of the Entomology Laboratory, Summerland, B.C., helped to collect the species described from British Columbia, and Mr. Morgan allowed me to study the phytoseiids at the Summerland laboratory. Finally, Dr. Evans, Dr. H. Dean, Weslaco, Texas, Dr. G. W. Krantz, Corvallis, Oregon, Dr. D. W. Clancy, Martinsburg, West Virginia, Dr. C. A. Fleschner, Riverside, California, Mr. R. O. Schuster, Davis, California, Mr. E. A. McGregor, Whittier, California, Miss June Herbert, Kentville, N.S., and Mr. W. L. Putman, Vineland, Ont., provided me with specimens of some of the species that occur in their areas.

REFERENCES

Anderson, N. H., C. V. G. Morgan, and D. A. Chant, 1958. Notes on the occurrence of *Typhlodromus* and *Phytoseius* spp. in southern British Columbia (Acarina: Phytoseiidae). *Canadian Ent.* 90: 275-279.

Athias-Henriot, C. 1957a. Phytoseiidae et Aceosejidae (Acarina, Gamasina) d'Algérie I. Genres *Blattisocius* Keegan, *Iphiseius* Berlese, *Amblyseius* Berlese, *Phytoseius* Ribaga, *Phytoseiulus* Evans. *Bull. Soc. Hist. Nat. Afrique Nord* 48: 319-352.

Athias-Henriot, C. 1957b. *Typhlodromus ornatus* n.sp. et *Typhlodromus longilaterus* n.sp. (Acarina, Phytoseiidae) mésostigmates prédateurs d'Algérie. *Rev. Pat. Veg. Ent. Agric. France* 36: 215-222.

Athias-Henriot, C. 1958. Phytoseiidae et Aceosejidae (Acarina, Gamasina) d'Algérie II. Phytoseiidae: clé des genres, genres *Amblyseius* Berlese (suite) et *Seiulus* Berlese. *Bull. Soc. Hist. Nat. Afrique Nord* 49: 23-43.

Athias-Henriot, C. 1959. Acariens planticoles d'Algérie I. 5e contribution au genre *Amblyseius* Berlese (Phytoseiidae). II. Première liste d'Actinochitinosi (Cheyletidae, Caligonellidae, Hemisarcoptidae). *Bull. Acad. Roy. Belgique (Ser. 5)* 45: 130-153.

Austin, M. D., and A. M. Massee. 1947. Investigations on the control of the fruit tree red spider mite (*Metatetranychus ulmi* Koch) during the dormant season. *J. Pomol.* 23: 227-253.

Baker, E. W., and G. W. Wharton. 1952. An introduction to acarology. The Macmillan Co., 465 pp.

Ballard, R. C. 1954. The biology of the predacious mite *Typhlodromus fallacis* (Garman) (Phytoseiidae) at 78°F. *Ohio J. Sci.* 54; 175-179.

Banks, N. 1904. A treatise on the Acarina or mites. *Proc. United States Nat. Mus.* 28: 114 pp.

Banks, N. 1905. Descriptions of some new mites. *Proc. Ent. Soc. Washington* 7: 133-142.

Banks, N. 1909. New Canadian mites. *Proc. Ent. Soc. Washington* 11: 133-143.

Banks, N. 1915. The Acarina or mites. *United States Dept. Agr. Rep.* 108. 153 pp.

Berlese, A. 1887. Acari, Myriapoda, et Scorpiones in Italia reperta. Fasc. 41. Padua.

Berlese, A. 1889. Acari, Myriapoda, et Scorpiones in Italia. Fasc. 54. Padua.

Berlese, A. 1914. Acari nuovi. *Redia* 10: 113-150.

Berlese, A. 1917. Centuria secunda di Acari nuovi. *Redia* 12: 172.

Berlese, A. 1917b. Centuria terza di Acari nuovi. *Redia* 12: 289-338.

Berlese, A. 1921. Acari, Myriapoda et Pseudoscorpiones Indice Sinonimico. *Redia* 14: 95.

Berlese, A. 1923. Centuria secunda di Acari nuovi. *Redia* 15: 255.

Blair, C. A. 1951. Damage to apple leaves by the fruit tree red spider mite, *Metatetranychus ulmi* (Koch). *Rep. E. Malling Res. Sta.* 1950: 152-154.

Blair, C. A., and J. R. Groves. 1952. Biology of the fruit tree red spider mite, *Metatetranychus ulmi* (Koch) in south-eastern England. *J. Hort. Sci.* 27: 14-43.

Canestrini, C., and F. Fanzago. 1876. Nuovi acari Italiani, ser. ii. *Atti. Soc. Veneto-Trent.* 5: 130-142.

Chant, D. A. 1955. Notes on mites of the genus *Typhlodromus* Scheuten, 1857 (Acarina: Laelaptidae), with descriptions of the males of some species and the females of a new species. *Canadian Ent.* 87: 496-503.

Chant, D. A. 1956. Some new mites of the subfamily Phytoseiinae (Acarina: Laelaptidae) from southeastern England, with descriptions of new species. *Canadian Ent.* 88: 26-37.

Chant, D. A. 1957a. Descriptions of some phytoseiid mites (Acarina: Phytoseiidae). Part I. Nine new species from British Columbia with keys to the species of British Columbia. Part II. Redescriptions of eight species described by Berlese. *Canadian Ent.* 89: 289-308.

Chant, D. A. 1957b. Note on the status of some genera in the family Phytoseiidae (Acarina). *Canadian Ent.* 89: 528-532.

Chant, D. A. 1957d. Descriptions of two new phytoseiid genera (Acarina: Phytoseiidae), with a note on the genus *Phytoseius* Ribaga, 1902. *Canadian Ent.* 89: 357-363.

Chant, D. A. 1958. Immature and adult stages of some British Phytoseiidae Berl. 1916 (Acarina). *J. Linn. Soc. London, Zoology* 43: 599-643.

Chant, D. A. 1959. Description of a new species of *Typhlodromus* (Acarina: Phytoseiidae) from Eastern Asia. *Canadian Ent.* 91: 29-31.

Chant, D. A., and R. C. Muir. 1955. A comparison of the imprint and brushing machine methods for estimating the number of fruit tree red spider mite, *Metatetranychus ulmi* (Koch), on apple leaves. *Rep. E. Malling Res. Sta.* 1954 (1955): 141-145.

Chant, D. A., H. A. Denmark, and E. W. Baker, 1959. A new subfamily, Macroseiinae Nov., of the family Phytoseiidae (Acarina: Gamasina). *Canadian Ent.* 91: 808-811.

Clancy, D. W., and H. N. Pollard. 1952. The effect of DDT on mite and predator populations in apple orchards. *J. Econ. Ent.* 45: 108-114.

Collyer, Elsie. 1949. The predator aspect of the fruit tree red spider problem. *Rep. E. Malling Res. Sta.* 1948: 108-110.

Collyer, Elsie. 1952. Biology of some predatory insects and mites associated with the fruit tree red spider mite (*Metatetranychus ulmi* (Koch)) in south-eastern England. I. The biology of *Blepharidopterus angulatus* (Fall.). *J. Hort. Sci.* 27: 117-129.

Collyer, Elsie. 1953a. *Idem.* IV. The predator-mite relationship. *J. Hort. Sci.* 28: 246-259.

Collyer, Elsie. 1953b. Insect population balance and chemical control of pests: predators of the fruit tree red spider mite. *Chem & Ind. (Rev.).* 1953: 1044-1046.

Collyer, Elsie. 1953c. Biology of some predatory insects and mites associated with the fruit tree red spider mite (*Metatetranychus ulmi* (Koch)) in south-eastern England. III. Further predators of the mite. *J. Hort. Sci.* 28: 98-113.

Collyer, Elsie. 1956. Notes on the biology of some predacious mites on fruit trees in south-eastern England. *Bull. Ent. Res.* 47: 205-214.

Collyer, Elsie. 1957. Two new species of the genus *Typhlodromus* Scheuten, 1857 (Acarina: Phytoseiidae). *Ann. Mag. Nat. Hist.* 12: 199-203.

Collyer, Elsie, and A. H. M. Kirby. 1955. Some factors affecting the balance of phytophagous and predacious mites on apple in south-eastern England. *J. Hort. Sci.* 30: 97-108.

Cooreman, J. 1943. Note sur la faune des hautes-fagnes en Belgique XI. Acariens (Parasitiformes). *Bull. Mus. Roy. Hist. Nat. Belgique* 19: 25.

Cottier, W. 1934. The natural enemies of the European red mite in New Zealand. *New Zealand J. Sci. Tech.* 16: 68-80.

Creighton, J. T. 1938. Factors influencing insect abundance. *J. Econ. Ent.* 31: 735-739.

Cunliffe, F., and E. W. Baker. 1953. A guide to the predatory phytoseiid mites of the United States. *Pinellas Biol. Lab. Pub.* No. 1.

Cutright, C. R. 1942. The season's experiments with red mite control. *Proc. Ohio Hort. Soc.* 75: 32-44.

Cutright, C. R. 1944. Populations of the European red mite as affected by spray schedules. *J. Econ. Ent.* 37: 499-502.

Dean, H. 1957. Predators of *Oligonychus pratensis* (Banks), Tetranychidae. *Ann. Ent. Soc. Amer.* 50: 164-165.

DeBach, P. 1946. An insecticidal check method for measuring the efficiency of entomophagous insects. *J. Econ. Ent.* 39: 695-697.

DeBach, P. 1951. The necessity for an ecological approach to pest control on citrus in California. *J. Econ. Ent.* 44: 443-447.

De Leon, D. 1957. Three new *Typhlodromus* from southern Florida (Acarina: Phytoseiidae). *Florida Ent.* 40: 141-144.

De Leon, D. 1959. A new genus and three new species of Phytoseiid mites from Mexico with collection records on *Phytoseius plumifer* (C. & F.) and *P. macropilis* (Banks). *Ent. News* 70: 147-152.

Dosse, G. 1957. Morphologie und Biologie von *Typhlodromus zwölferi* n.sp. (Acar., Phytoseiidae). *Z. Angew. Ent.* 41: 301-311.

Dosse, G. 1958a. Über einige neue Raubmilbenarten (Acar. Phytoseiidae). *Pflanzen. Berichte* 21: 44-61.

Dosse, G. 1958b. Die Spermathecae, ein zusätliches Bestimmungsmerkmal bei Raubmilben (Acar., Phytoseiidae). Ibid. 20: 1-11.

Ehara, S. 1958. Three predatory mites of the genus *Typhlodromus* from Japan (Phytoseiidae). *Annot. Zool. Japonenses* 31: 53-57.

Ehara, S. 1959. Some predatory mites of the genera *Typhlodromus* and *Amblyseius* from Japan (Phytoseiidae). *Acarologia* 1: 285-295.

Errington, P. L. 1946. Predation and vertebrate populations. *Quart. Rev. Biol.* 21: 144-177, 221-245.

Evans, G. Owen. 1952a. A new typhlodromid mite predacious on *Tetranychus bimaculatus* Harvey in Indonesia. *Ann. Mag. Nat. Hist.* 5: 413-416.

Evans, G. Owen. 1952b. On a new predatory mite of economic importance. *Bull. Ent. Res.* 43: 397-401.

Evans, G. Owen. 1953. On some mites of the genus *Typhlodromus* Scheuten, 1857, from S.E. Asia. *Ann. Mag. Nat. Hist.* 6: 449-467.

Evans, G. Owen. 1954. The genus *Iphiseius* Berl. (Acarina: Laelaptidae). *Proc. Zool. Soc. London* 124: 517-526.

Evans, G. Owen. 1957. The genera *Podocinum* Berl. and *Podocinella* gen. nov. (Acarina: Mesostigmata). *Ann. Mag. Nat. Hist., Ser. 12,* 10: 913-932.

Evans, G. Owen. 1958. An introduction to the British Mesostigmata (Acarina) with keys to families and genera. *J. Linn. Soc.* 43: 203-259.

Evans, G. Owen. 1959. Some mesostigmatid mites from a nest of social spiders in Uganda. *Ann. Mag. Nat. Hist., Ser. 13,* 1: 580-590.

Fleschner, C. A., and D. W. Ricker. 1953. Natural enemies of mites on avocados. *California Citrusgr.* 38: 418-419.

Fleschner, C. A., and D. W. Ricker. 1954. Typhlodromid mites on citrus and avocado trees in southern California. *J. Econ. Ent.* 47: 356-357.

Fox, I. 1946. A new genus, *Borinquolaelaps,* and new species of mites from rats in Puerto Rico. *J. Parasitol.* 32: 445-452.

Fox, I. 1949. Five new mites from rats in Puerto Rico. *Florida Ent.* 32: 37-40.

Garman, P. 1937. Connecticut State Entomologist, 36th report. 1936. *Bull. Connecticut Agr. Expt. Sta.* 396: 372-377.

Garman, P. 1938. Connecticut State Entomologist, 37th report. 1937. *Ibid.* 408: 219-220.

Garman, P. 1948. Mite species from apple trees in Connecticut. *Ibid.* 520.

Garman, P. 1958. New species belonging to the genera *Amblyseius* and *Amblyseiopsis,* with keys to *Amblyseius, Amblyseiopsis,* and *Phytoseiulus. Ann. Ent. Soc. Amer.* 51: 69-79.

Garman, P., and E. A. McGregor. 1956. Four new predaceous mites (Acarina: Phytoseiidae). *Bull. Southern California Acad. Sci.* 55: 7-13.

Garman, P., and S. F. Townsend. 1938. The European red mite and its control. *Bull. Connecticut Agr. Expt. Sta.* 418.

Gilliatt, F. C. 1935. Some predators of the European red mite, *Paratetranychus pilosus* C. & F., in Nova Scotia. *Canadian J. Res.* (D) 13: 19-38.

Henderson. C. F., and H. V. McBurnie. 1943. Sampling techniques for determining populations of citrus red mite and its predators. *United States Dept. Agr. Circ.* 671.

Herbert, H. J. 1953. Progress report on predacious mite investigations in Nova Scotia (Acarina: Phytoseiidae). *Rep. Ent. Soc. Ontario* (1952): 27-29.

Herbert, H. J. 1956. Laboratory studies on some factors of the life-history of the predacious mite *Typhlodromus tiliae* Oudms. (Acarina: Phytoseiidae). *Canadian Ent.* 88: 701-704.

Holloway, J. K., C. F. Henderson, and H. V. McBurnie. 1942. Population increase of citrus red mite associated with the use of sprays containing inert granular residues. *J. Econ. Ent.* 35: 348-350.

Houser, J. S., and C. R. Cutright. 1941. The European red mite. *Proc. Ohio Hort. Soc.* 74: 26-34.

Hueck, H. J., D. J. Kuenen, P. J. Den Boer, and E. Jaegar-Draafsel. 1952. The increase of egg-production of the fruit tree red spider mite (*Metatetranychus ulmi* Koch) under influence of DDT. *Physiol. Comp.* 2: 371-377.

Hughes, A. M. 1948. The mites associated with stored food products. *Min. Agr. Fish., London.* H. M. Stationery Office. 168 pp.

Huffaker, C. B., and C. E. Kennett. 1953. Developments towards biological control of cyclamen mite on strawberries in California. *J. Econ. Ent.* 46: 802-812.

Huffaker, C. B., and C. E. Kennet. 1956. Experimental studies on predation: predation and cyclamen-mite populations on strawberries in California. *Hilgardia* 26: 191-222.

Kennett, C. 1958. Some predacious mites of the subfamilies Phytoseiinae and Aceosejinae (Acarina: Phytoseiidae, Aceosejidae) from Central California with descriptions of new species. *Ann. Ent. Soc. America* 51: 471-479.

Koch, C. L. 1839. Deutschlands Crustaceen, Myriapoden, und Arachniden. Regensburg.

Kuenen, D. J. 1946. Het fruitspint en zijn bestrijding. *Meded. Tuinbouw.* 44. 68 pp.

Kuenen, D. J. 1947. On the ecological significance of two predators of *Metatetranychus ulmi* C. L. Koch (Acari: Tetranychidae). *Tijdschr. Ent.* 88: 303-312.

Quenen, D. J. 1949. The fruit tree red spider (*Metatetranychus ulmi* Koch) and its relation to its host plant. *Tijdschr. Ent.* 91: 83-102.

Lack, D. 1954. The natural regulation of animal numbers. Clarendon Press, London.

Listo, J., E. M. Listo, and V. Kanervo. 1939. Tutkimuksia hedelmapuupunkista (*Paratetranychus pilosus* C. & F.). *Valt. Mataloush. Julk.* 99: 143 pp.

Lord, F. T. 1949. The influence of spray programs on the fauna of apple orchards in Nova Scotia: III. Mites and their predators. *Canadian Ent.* 81: 202-230.

MacGill, Elsie I. 1939. A gamasid mite (*Typhlodromus thripsi* n. sp.), a predator of *Thrips tabaci* Lind. *Ann. Appl. Biol.* 26: 309-317.

Marle, Greta. 1951. Observations on the dispersal of the fruit tree red spider mite, *Metatetranychus ulmi* (Koch). *Rep. E. Malling Res. Sta.* 1950: 155-159.

Massee, A. M. 1932. Some injurious and beneficial mites on top and soft fruits. *J. Pomol.* 10: 106-129.

Massee, A. M. 1953. Insect population balance and chemical control of pests: Insecticides in apple orchards. *Chem. & Ind. (Rev.)* 1953: 1004-1005.

Massee, A. M. 1954. The pests of fruit and hops. Crosby Lockwood & Sons, Ltd., London.

Massee, A. M. 1955. Problems arising from the use of insecticides: Effects on balance of animal populations. *Rep. E. Malling Res. Sta.* 1954 (1955): 137-140.

Mathys, G. 1954. Contribution éthologique à la résolution du complexe *Bryobia praetiosa* Koch (Acar., Tetranych.). *Mitt. Schweiz. Ent. Ges.* 27: 137-146.

McGregor, E. A. 1954. Two new mites in the genus *Typhlodromus* (Acarina, Phytoseiidae). *Bull. Southern California Acad. Sci.* 53: 89-92.

McGregor, E. A. 1956. The mites of citrus trees in southern California. *Mem. Southern California Acad. Sci.* 3: 5-42.

Morgan, C. V. G. 1952. Effects of low winter temperatures on some orchard mites. *Proc. Ent. Soc. British Columbia* 48: 90-93.

Morgan, C. V. G., and N. H. Anderson. 1957. Some aspects of a ryania-glyodin spray schedule in British Columbia apple orchards. I. Entomological, horticultural, and economic aspects. *Canadian J. Plant Sci.* 37: 423-433.

Morgan, C. V. G., and N. H. Anderson. 1958. Notes on parathion-resistant strains of two phytophagous mites and a predacious mite in British Columbia. *Canadian Ent.* 90: 92-97.

Morgan, C. V. G., D. A. Chant, N. H. Anderson, and G. L. Ayre. 1955. Methods for estimating orchard mite populations, especially with the mite brushing machine. *Canadian Ent.* 87: 189-200.

Muma, M. H. 1955a. Factors contributing to the natural control of citrus mites in Florida. *J. Econ. Ent.* 48: 432-438.

Muma, M. H. 1955b. Phytoseiidae (Acarina) associated with citrus in Florida. *Ann. Ent. Soc. Amer.* 48: 262-272.

Nesbitt, H. H. J. 1946. Three new mites from Nova Scotia apple trees. *Canadian Ent.* 78: 15-22.

Nesbitt, H. H. J. 1951. A taxonomic study of the Phytoseiinae (Family Laelaptidae) predaceous upon Tetranychidae of economic importance. *Zool. Verh.* 12.

Nesbitt, H. H. J. 1954. Random notes on the mite fauna of Limburg. *Natuur. Maanblad.* 43: 19-24.

Newcomer, E. J., and M. A. Yothers. 1929. Biology of the European red mite in the Pacific northwest. *United States Dept. Agr. Bull.* 89. 70 pp.

Nicholson, A. J. 1954. An outline of the dynamics of animal populations. *Australian J. Zool.* 2: 9-65.

Oudemans, A. C. 1905. Bizonderheden over bekende en nieuwe Acari. *Tijdschr. Ent.* 48: lxxvii-lxxxi.

Oudemans, A. C. 1915a. Acarologische aanteekeningen 56: *Ent. Bericht.* 4: 180-188.

Oudemans, A. C. 1915b. *Arch. Naturges.* 81A: 159-161.

Oudemans, A. C. 1929. Acarologische aanteekeningen 100. *Ent. Bericht.* 8: 11-36.

Oudemans, A. C. 1930. *Idem.* 101-103. *Ent. Bericht.* 8: 48-99

Parrott, P. J., H. E. Hodgkiss, and W. J. Schoene. 1906. The Eriophyidae Part I. The apple and pear mites. *New York Agr. Expt. Sta. Bull.* 283: 302-303.

Peterson, A. 1953. A manual of entomological techniques. Edwards Bros., Inc., Ann Arbor.

Pickett, A. D., N. A. Patterson, H. T. Stultz, and F. T. Lord. 1946. The influence of spray programs on the fauna of apple orchards in Nova Scotia: I. An appraisal of the problem and a method of approach. *Sci. Agr.* 26: 590-600.

Pickett, A. D., and N. A. Patterson. 1953. *Idem.* IV. A Review. *Canadian Ent.* 85: 472-478.

Putman, W. L. 1955. Bionomics of *Stethorus punctillum* Weise (Coleoptera: Coccinellidae) in Ontario. *Canadian Ent.* 87: 9-33.

Ribaga, C. 1902. Gamasidi planticoli. *Riv. Pat. Veg.* 10: 175-178.

Rodriguez, J. G. 1951. Mineral nutrition of the two-spotted spider mite, *Tetranychus bimaculatus* Harvey. *Ann. Ent. Soc. Amer.* 44: 511-526.

Schuster, R. O. 1957. A new species of *Typhlodromus* from California (Phytoseiidae: Acarina). *Pan-Pacific Ent.* 33: 203-205.

Schuster, R. O. 1959. A new species of *Typhlodromus* near *T. bakeri* (Garman) and a consideration of the occurrence of *T. rhenanus* (Oud.) in California. *Proc. Ent. Soc. Washington* 61: 88-90.

Scheuten, A. 1857. Einiges über Milben. *Arch. Naturges.* 23: 104-112.

Schweizer, J. 1922. Beitrag zur Kenntnis der terrestrischen Milbenfauna der Schweiz. *Verh. Naturf. Ges. Basel.* 33: 23-112.

Schweizer, J. 1949. Die Landmilben des Schweizerischen Nationalparkes. *Ergeb. Wissenschaftl. Untersuchung. Schweiz. Nationalparkes* 2: 79.

Smith, H. E., and P. DeBach. 1942. The measurement of the effect of entomophagous insects on populations of their hosts. *J. Econ. Ent.* 35: 845-849.

Smith, L. M., and F. M. Summers. 1949. The structure and biology of the red spider predator "*Hypoaspis*" *macropilis* (Banks). *Proc. Ent. Soc. Washington.* 51: 209-218.

Solomon, M. E. 1949. The natural control of animal populations. *J. Anim. Ecol.* 18. 1-35.

Solomon, M. E. 1957. Dynamics of insect populations. *Ann. Rev. Ent.* 2: 121-142.

Thor, Sig. 1930. Beitrage zur Kenntnis der Invertebraten Fauna von Svalbard. *Skrift. Svalbard Ishavet* 27: 1-156.

Ullyett, G. C. 1953. Biomathematics and insect population problems. *Mem. Ent. Soc. South Africa* 2. 89 pp.

Venables, E. P., and A. A. Dennys. 1941. A new method of counting orchard mites. *J. Econ. Ent.* 34: 324.

Vitzthum, Graf H. von. 1941. Acarina *in* Bronns Klassen und Ordnungen des Terreichs 5 (iv): 764-767.

Wainstein, A. 1958. New species of *Typhlodromus* (Parasitiformes: Phytoseiidae) from Georgia [*In Russian*]. *J. Acad. Gruzia* 21(2): 201-207.

Wainstein, A. 1959. A new subgenus and species of the genus *Phytoseius* Ribaga, 1902 (Phytoseiidae, Parasitiformes). *Zool. Zhurn.* 38: 1361-1365.

Willmann, C. 1949. Beitrage zur Kenntnis der Salzgebietes von Ciechocinek. *Verhoff. Mus. Nat. Bremen* 1: 117.

Willman, C. 1952. Dei Milbenfauna der Noorseeinsel Wangerooge. *Verhoff. Inst. Meeres. Bremerhaven.* 1: 146

Womersley, H. 1954. Species of the subfamily Phytoseiinae (Acarina: Laelaptidae) from Australia. *Australian J. Zool.* 2: 169-191.

(Received May 4, 1959)

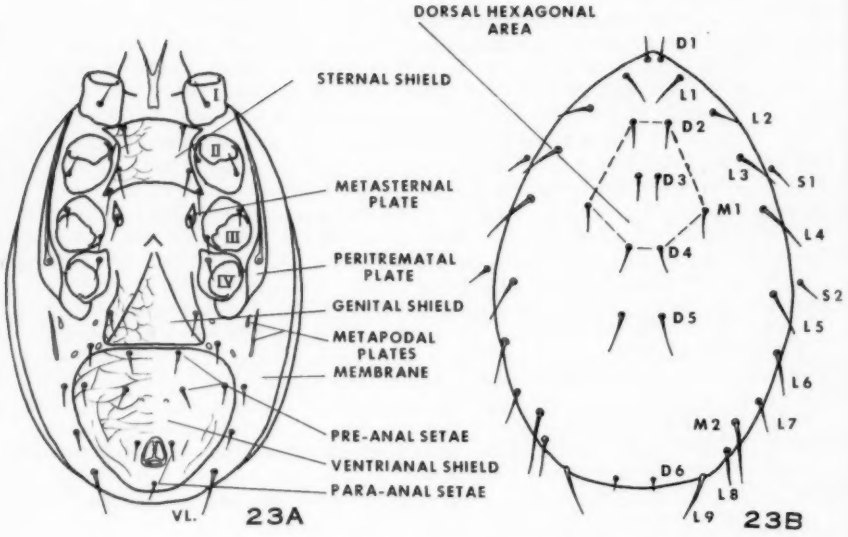
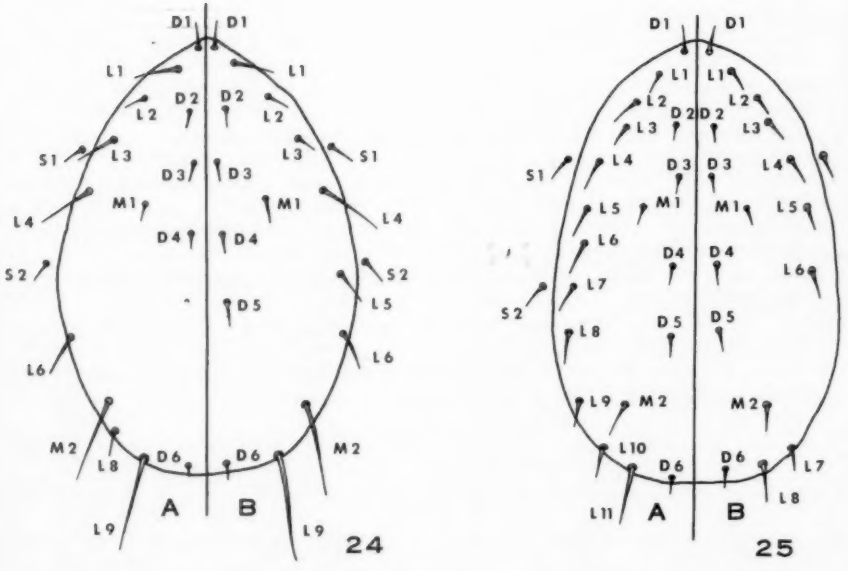
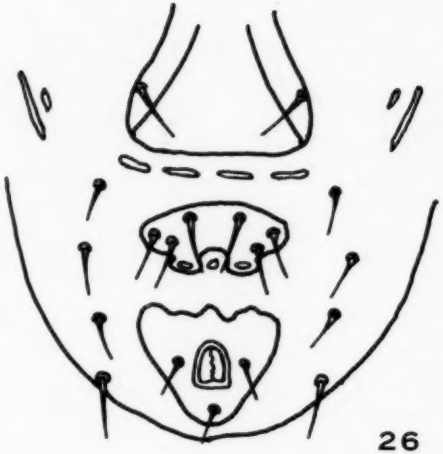
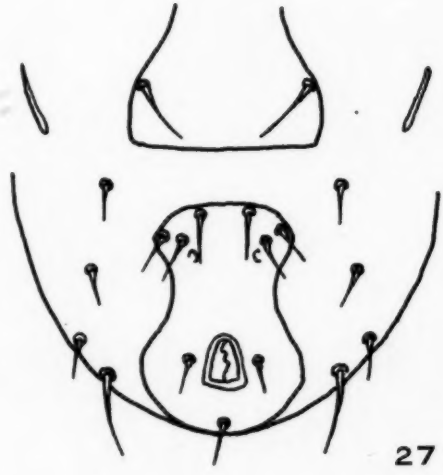


Fig. 23. Subgenus *Amblyseius*, dorsal (B) and ventral (A) surfaces.

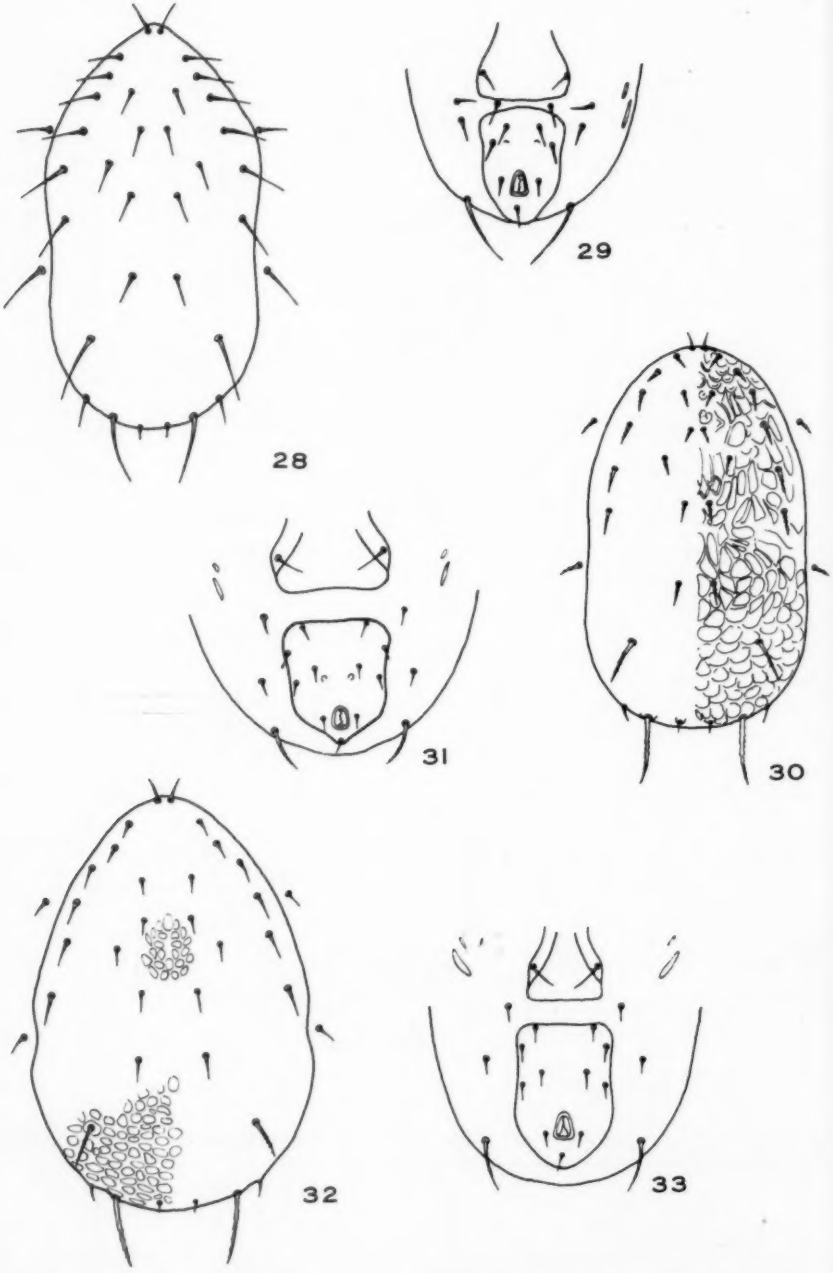


Figs. 24, 25. 24, subgenus *Amblyseius*, two types of dorsal chaetotaxies; 25, subgenus *Typhlodromus*, two types of dorsal chaetotaxies.

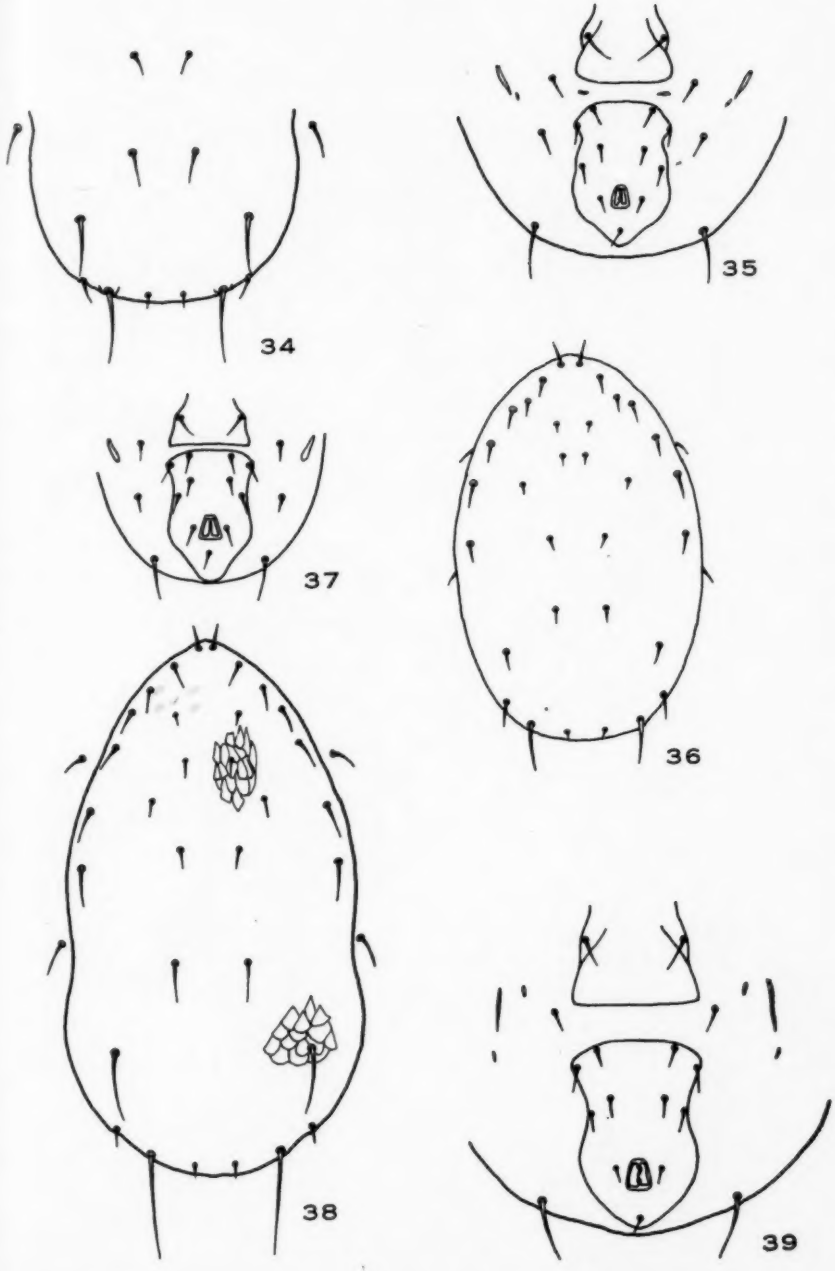




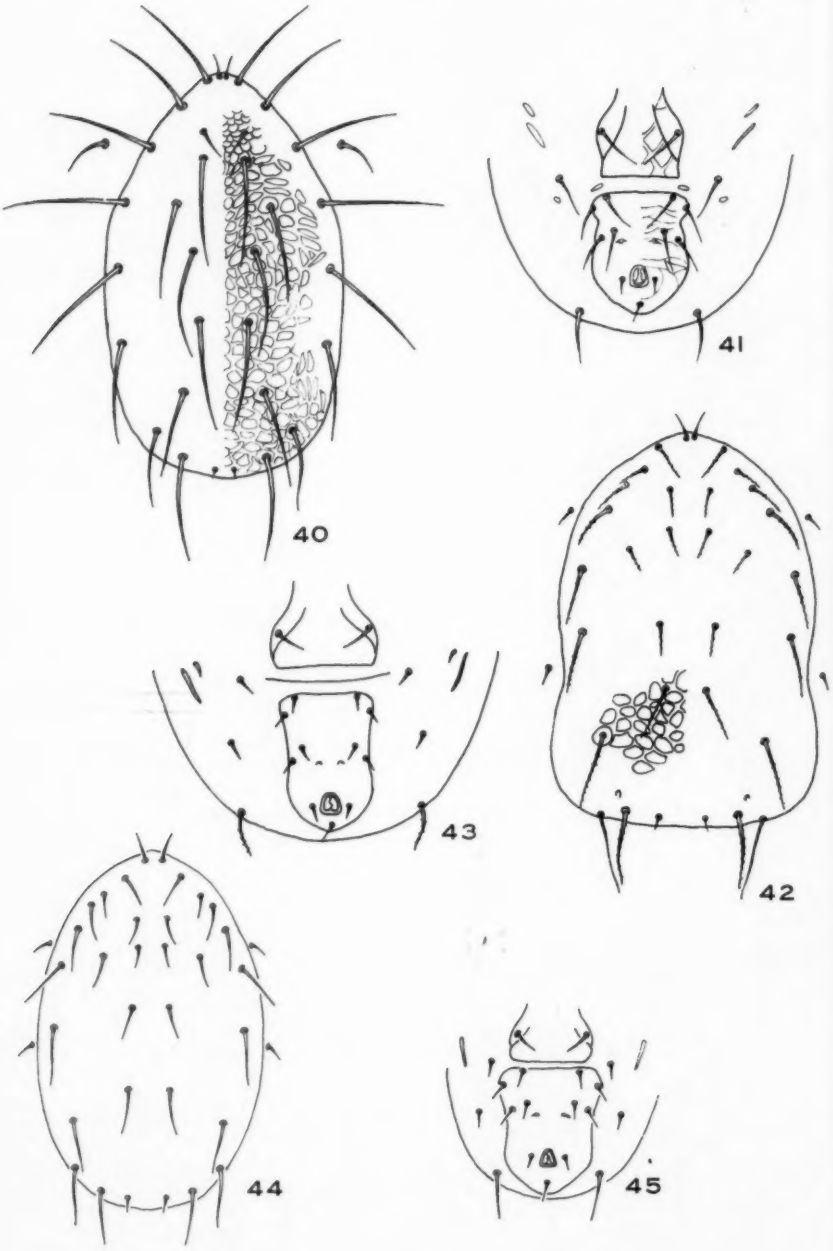
Figs. 26, 27. 26, fragmented ventrianal shield of *Iphiseius degenerans;* 27, entire ventrianal shield of *Typhlodromus* and other genera in Phytoseiidae.



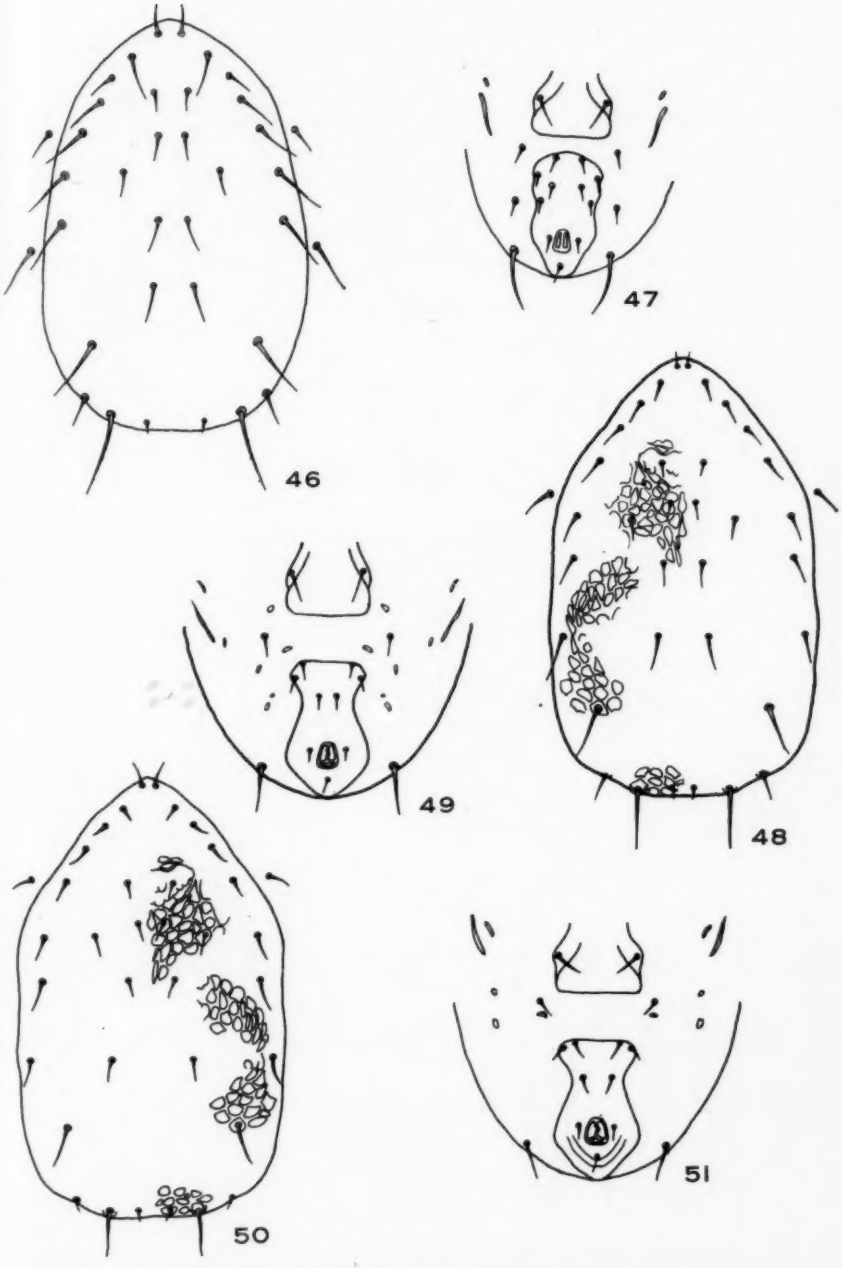
Figs. 28-33. *Typhlodromus* (*Typhlodromus*) spp. 28, 29. *T.* (*T.*) *smithi* Schuster. 28, dorsal surface; 29, posterior ventral surface. 30, 31. *T.* (*T.*) *burrelli* sp.n. 30, dorsal surface; 31, posterior ventral surface. 32, 33. *T.* (*T.*) *perplexus* sp.n. 32, dorsal surface; 33, posterior ventral surface.



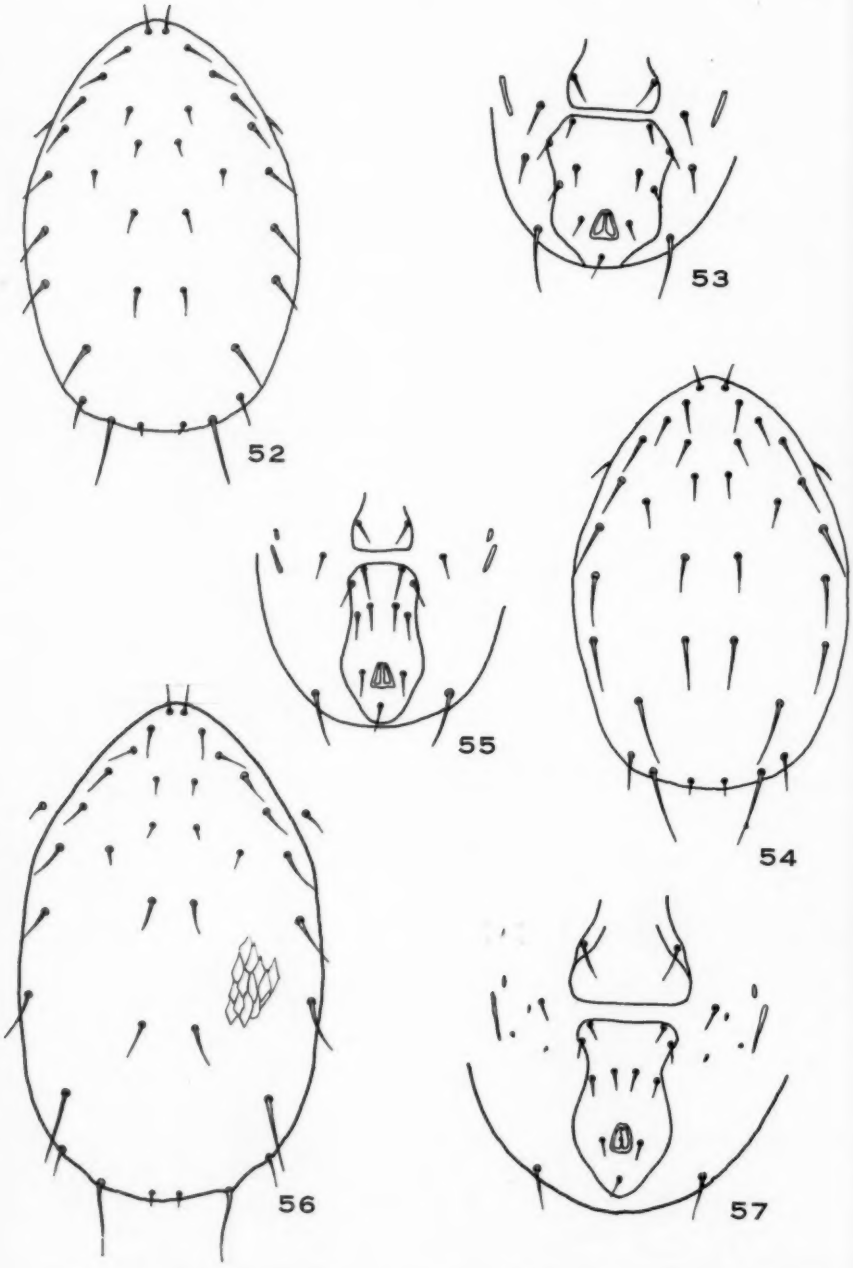
Figs. 34-39. *Typhlodromus* (*Typhlodromus*) spp. 34, 35. *T.* (*T.*) *arboreus* Chant. 34, dorsal surface; 35, posterior ventral surface. 36, 37. *T.* (*T.*) *pini* Chant. 36, dorsal surface; 37, posterior ventral surface. 38, 39. *T.* (*T.*) *columbiensis* sp.n. 38, dorsal surface; 39, posterior ventral surface.



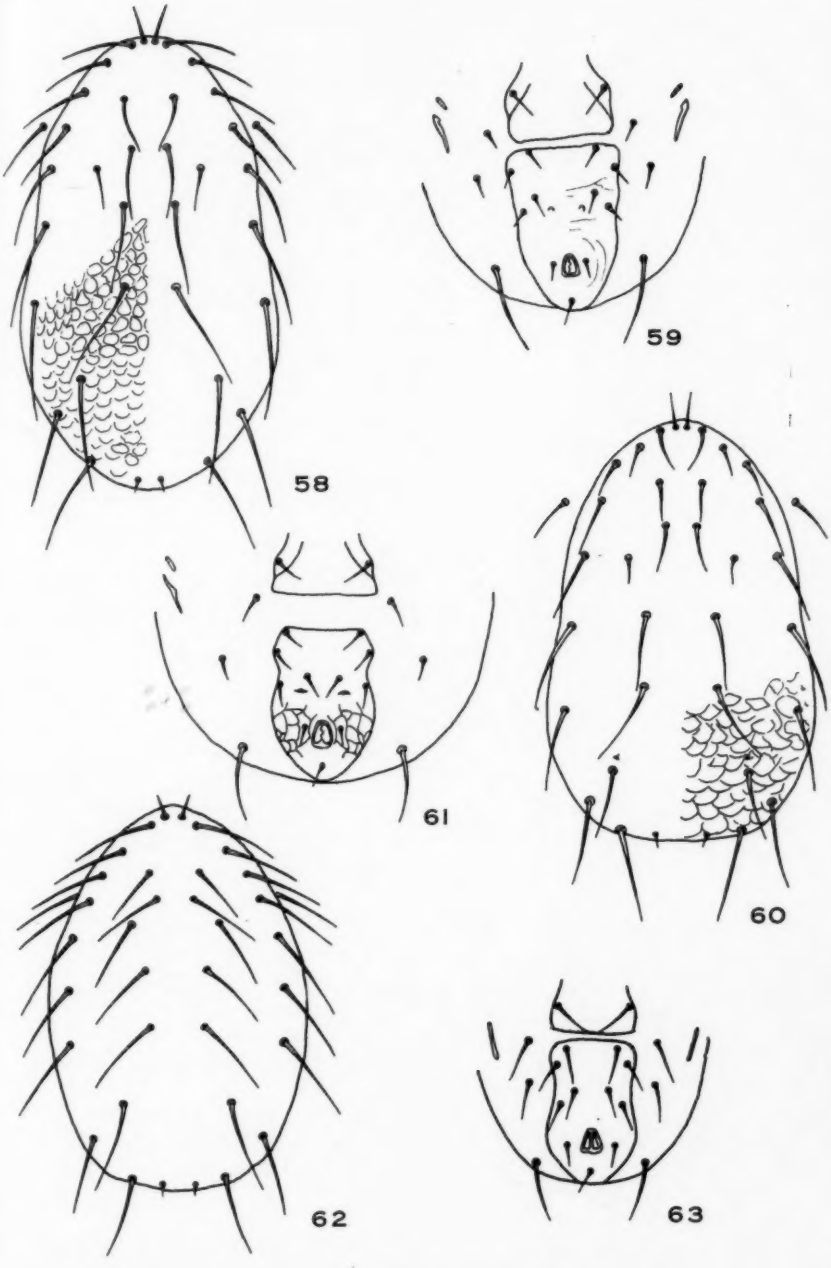
Figs. 40-45. *Typhlodromus* (*Typhlodromus*) spp. 40, 41. *T.* (*T.*) *pilosus* sp.n. 40, dorsal surface; 41, posterior ventral surface. 42, 43. *T.* (*T.*) *tropicus* sp.n. 42, dorsal surface; 43, posterior ventral surface. 44, 45. *T.* (*T.*) *conspicuus* (Garman). 44, dorsal surface; 45, posterior ventral surface.



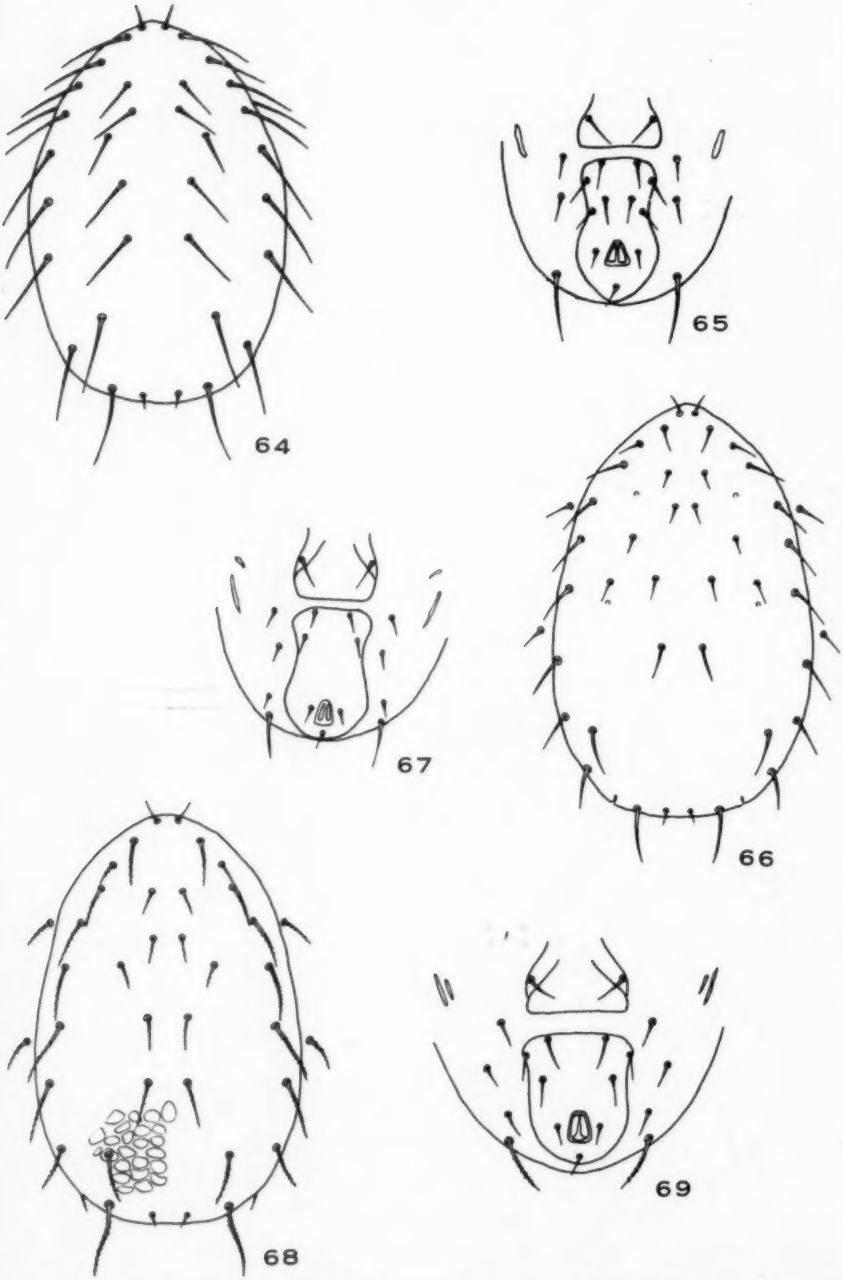
Figs. 46-51. *Typhlodromus* (*Typhlodromus*) spp. 46, 47. *T.* (*T.*) *herbertae* sp.n. 46, dorsal surface; 47, posterior ventral surface. 48, 49. *T.* (*T.*) *validus* Chant. 48, dorsal surface; 49, posterior ventral surface. 50, 51. *T.* (*T.*) *nelsoni* sp.n. 50, dorsal surface; 51, posterior ventral surface.



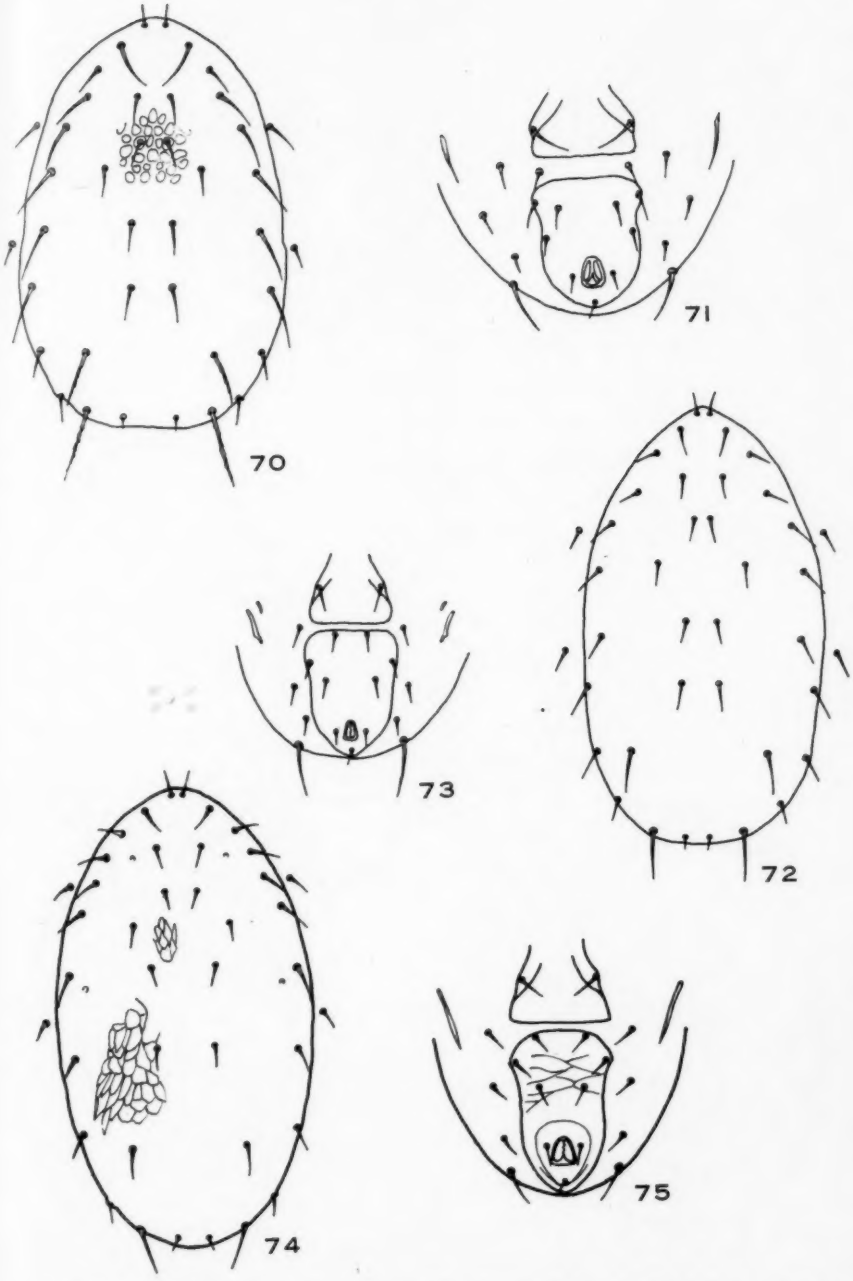
Figs. 52-57. *Typhlodromus* (*Typhlodromus*) spp. 52, 53. *T.* (*T.*) *pomi* (Parrott). 52, dorsal surface; 53, posterior ventral surface. 54, 55. *T.* (*T.*) *mcgregori* sp.n. 54, dorsal surface; 55, posterior ventral surface. 56, 57. *T.* (*T.*) *flumenis* Chant. 56, dorsal surface; 57, posterior ventral surface.



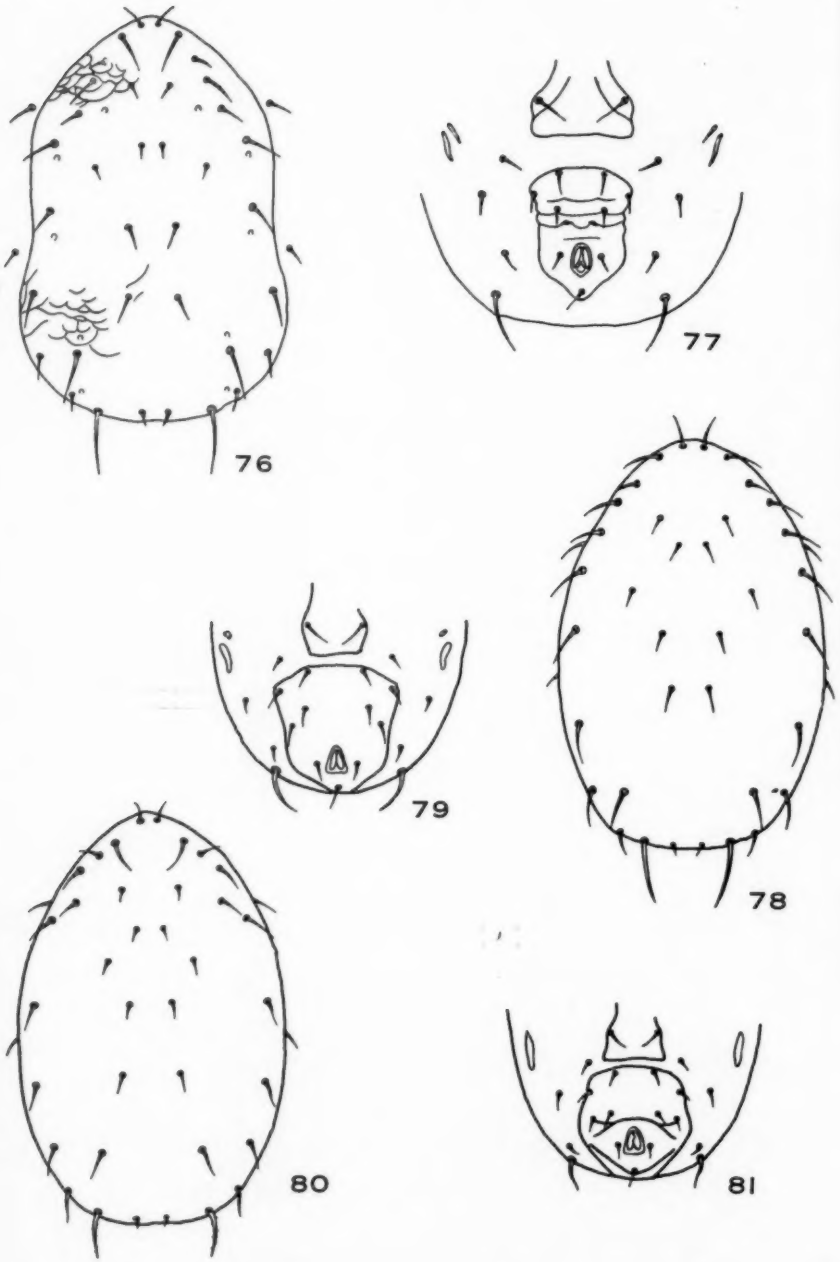
Figs. 58-63. *Typhlodromus* (*Typhlodromus*) spp. 58, 59. *T.* (*T.*) *helveolus* nom. n. 58, dorsal surface; 59, posterior ventral surface. 60, 61. *T.* (*T.*) *gratus* sp.n. 60, dorsal surface; 61, posterior ventral surface. 62, 63. *T.* (*T.*) *longipilis* Nesbitt. 62, dorsal surface; 63, posterior ventral surface.



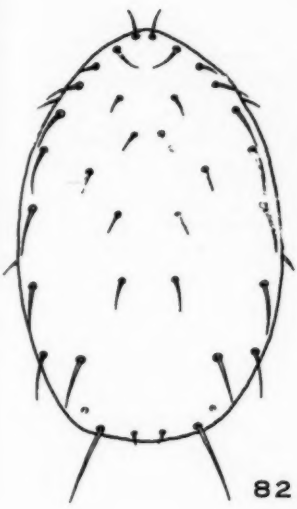
Figs. 64-69. *Typhlodromus* (*Typhlodromus*) spp. 64, 65. *T.* (*T.*) *occidentalis* Nesbitt. 64, dorsal surface; 65, posterior ventral surface. 66, 67. *T.* (*T.*) *soleiger* (Ribaga) 66, dorsal surface; 67, posterior ventral surface. 68, 69. *T.* (*T.*) *transvaalensis* (Nesbitt). 68, dorsal surface; 69, posterior ventral surface.



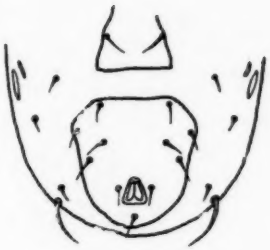
Figs. 70-75. *Typhlodromus* (*Typhlodromus*) spp. 70, 71. *T.* (*T.*) *invectus* sp.n. 70, dorsal surface; 71, posterior ventral surface. 72, 73. *T.* (*T.*) *barkeri* (Hughes). 72, dorsal surface; 73, posterior ventral surface. 74, 75. *T.* (*T.*) *singularis* Chant. 74, dorsal surface; 75, posterior ventral surface.



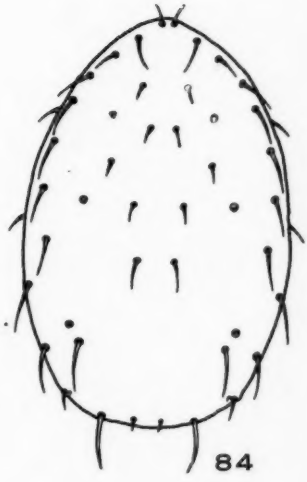
Figs. 76-81. *Typhlodromus* (*Typhlodromus*) spp. 76, 77. *T.* (*T.*) *juniperus* sp.n. 76, dorsal surface; 77, posterior ventral surface. 78, 79. *T.* (*T.*) *rhenanus* (Oudemans). 78, dorsal surface; 79, posterior ventral surface. 80, 81. *T.* (*T.*) *bakeri* (Garman). 80, dorsal surface; 81, posterior ventral surface.



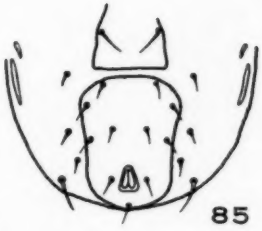
82



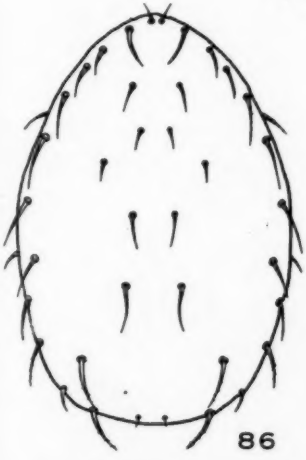
83



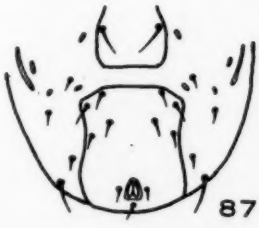
84



85

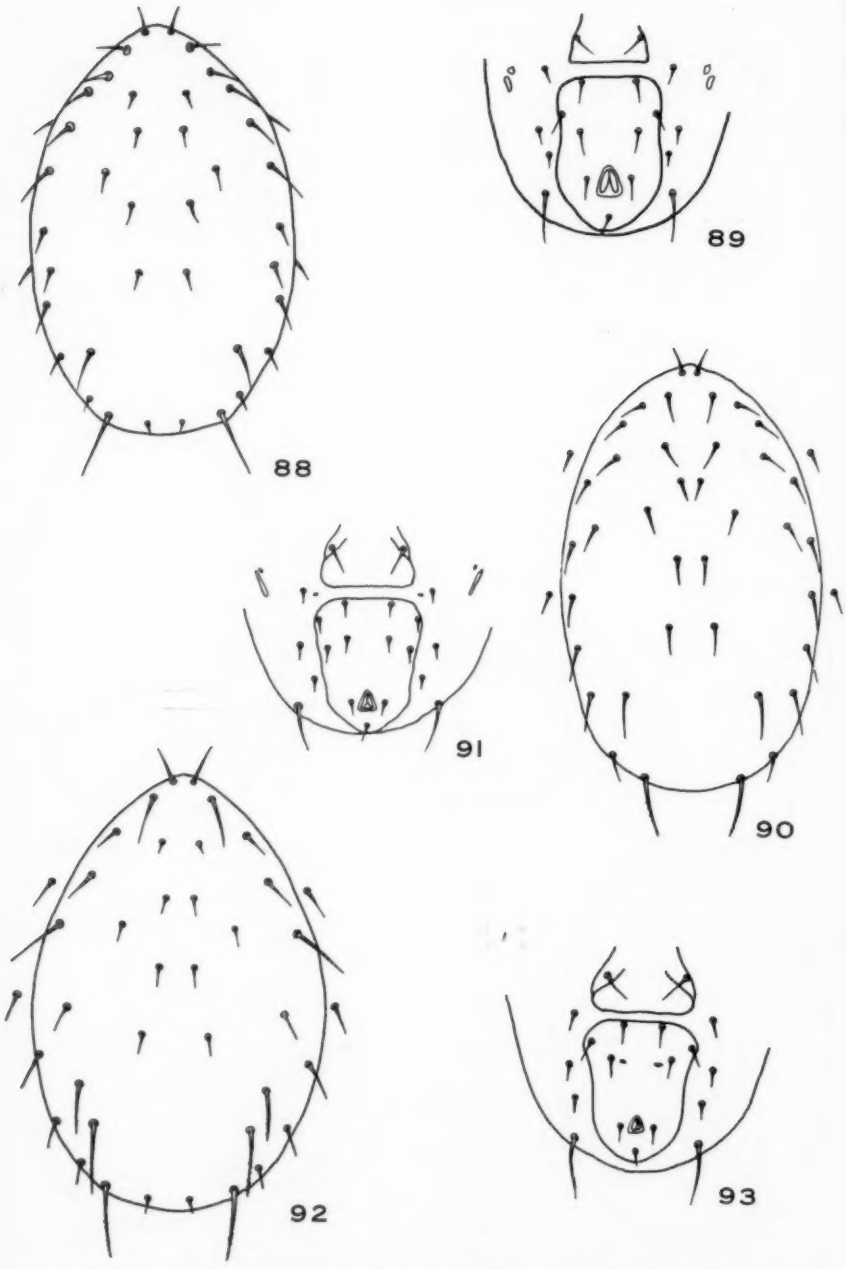


86

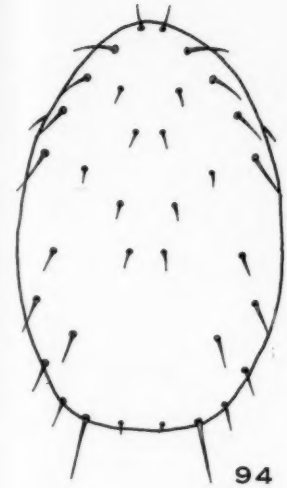


87

Figs. 82-87. *Typhlodromus* (*Typhlodromus*) spp. 82, 83. *T.* (*T.*) *pyri* Scheuten. 82, dorsal surface; 83, posterior ventral surface. 84, 85. *T.* (*T.*) *tiliarum* Oudemans. 84, dorsal surface; 85, posterior ventral surface. 86, 87. *T.* (*T.*) *aceri* Collyer. 86, dorsal surface; 87, posterior ventral surface.

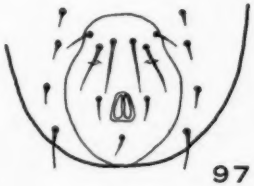


Figs. 88-93. *Typhlodromus* spp. 88, 89. *T.* (*Typhlodromus*) *nesbitti* Womersley. 88, dorsal surface; 89, posterior ventral surface. 90, 91. *T.* (*T.*) *australicus* (Womersley). 90, dorsal surface; 91, posterior ventral surface. 92, 93. *T.* (*Amblyseius*) *sextus* (Garman) comb.n. 92, dorsal surface; 93, posterior ventral surface.

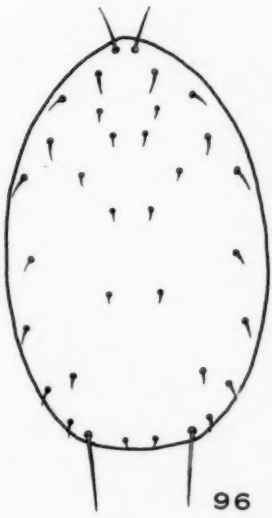


94

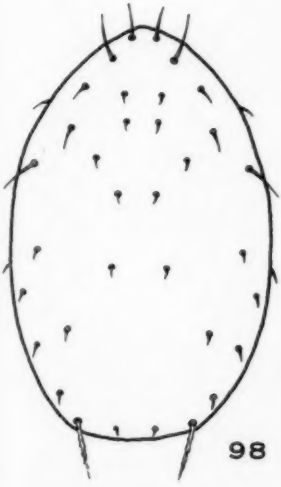
95



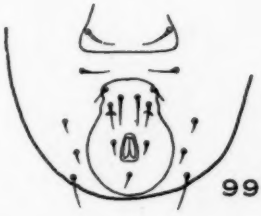
97



96

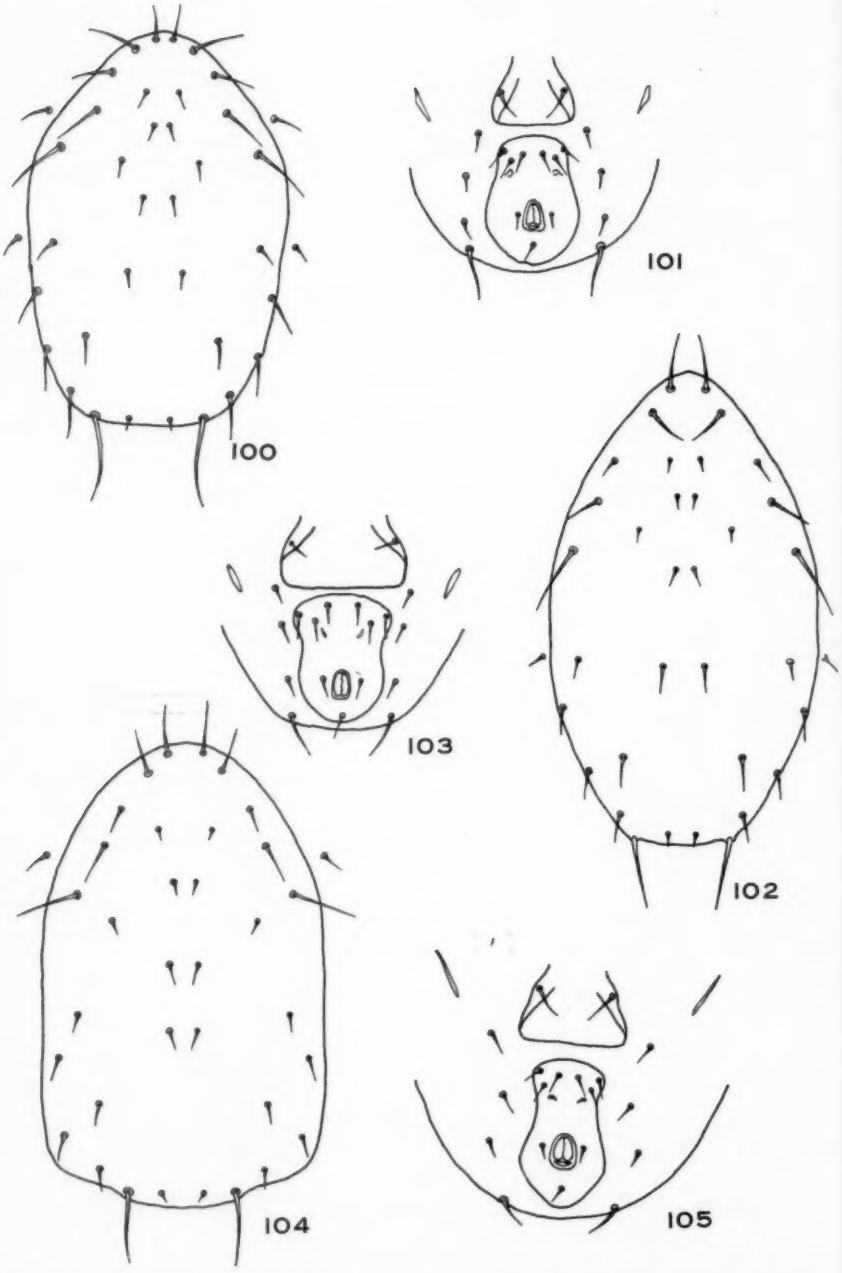


98

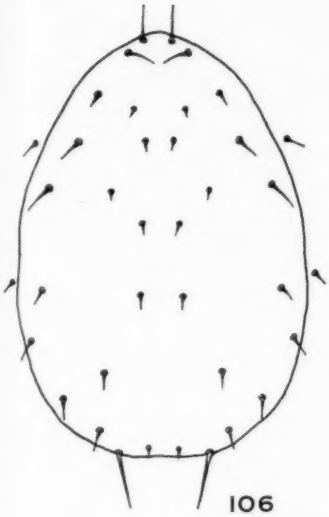


99

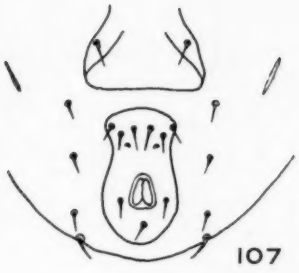
Figs. 94-99. *Typhlodromus* (*Amblyseius*) spp. 94, 95. *T.* (*A.*) *finlandicus* (Oudemans). 94, dorsal surface; 95, posterior ventral surface. 96, 97. *T.* (*A.*) *ovalis* Evans. 96, dorsal surface, 97, posterior ventral surface. 98, 99. *T.* (*A.*) *victoriensis* Womersley. 98, dorsal surface; 99, posterior ventral surface.



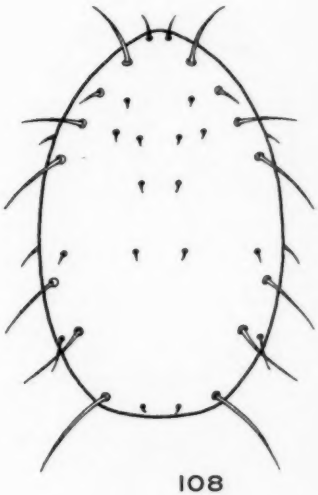
Figs. 100-105. *Typhlodromus* (*Amblyseius*) spp. 100, 101. *T.* (*A.*) *hibisci* sp.n. 100, dorsal surface; 101, posterior ventral surface. 102, 103. *T.* (*A.*) *aferulus* sp.n. 102, dorsal surface; 103, posterior ventral surface. 104, 105. *T.* (*A.*) *concordis sp.n.* 104, dorsal surface; 105, posterior ventral surface.



106

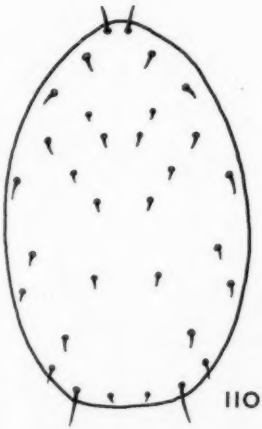


107

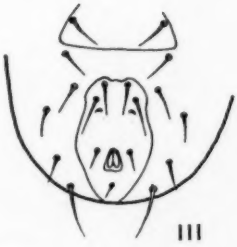


108

109

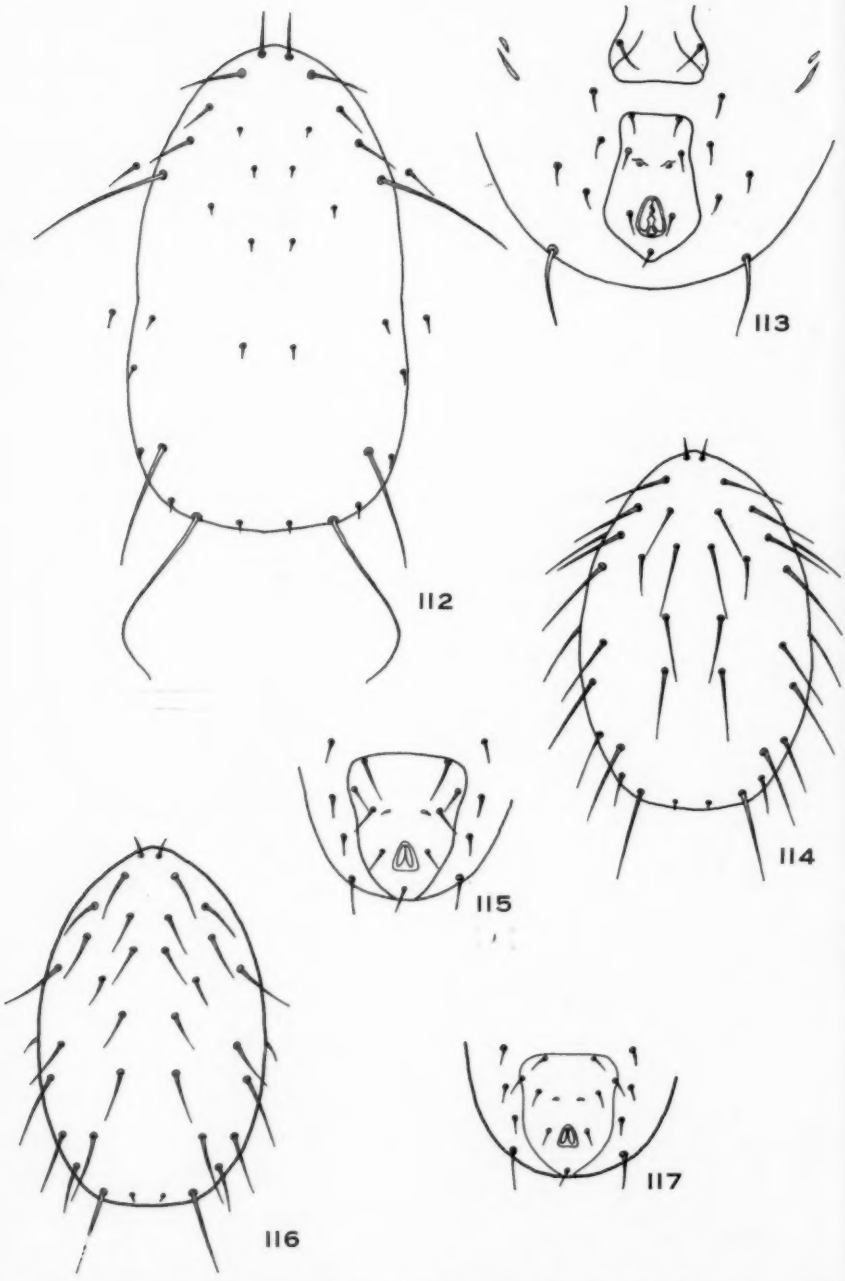


110

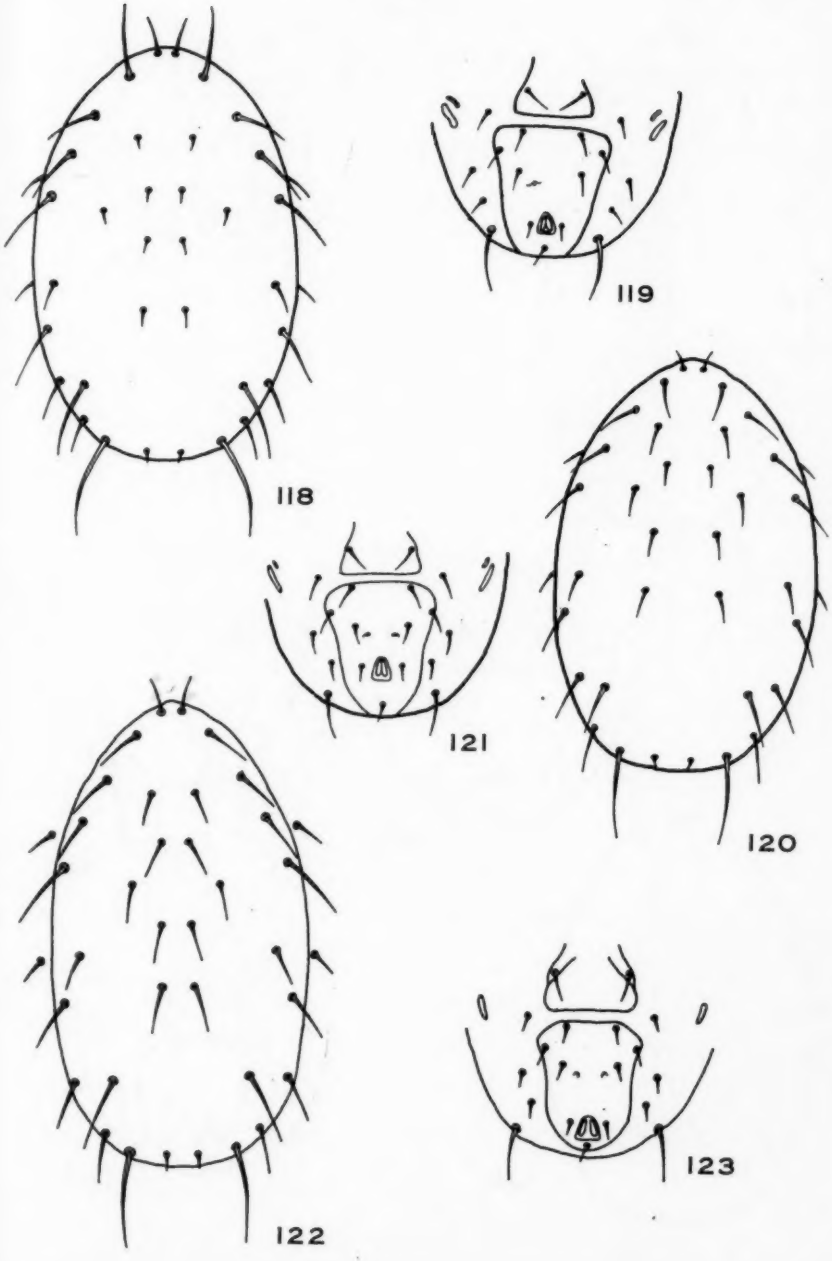


111

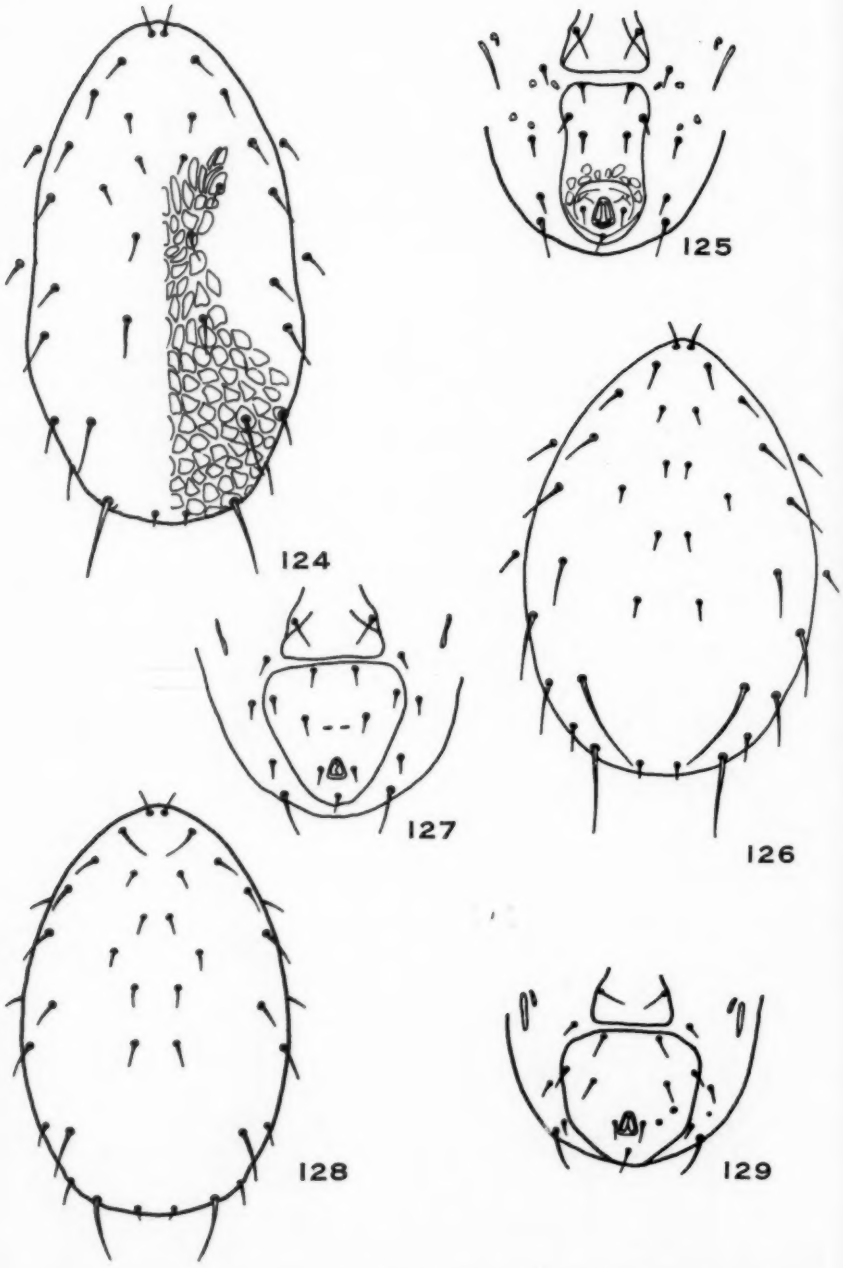
Figs. 106-111. *Typhlodromus* (*Amblyseius*) spp. 106, 107. *T.* (*A.*) *mesembrinus* Dean. 106, dorsal surface; 107, posterior ventral surface. 108, 109. *T.* (*A.*) *setosus* (Muma) comb. n. 108, dorsal surface, 109, posterior ventral surface. 110, 111. *T.* (*A.*) *irregularis* Evans. 110, dorsal surface; 111, posterior ventral surface.



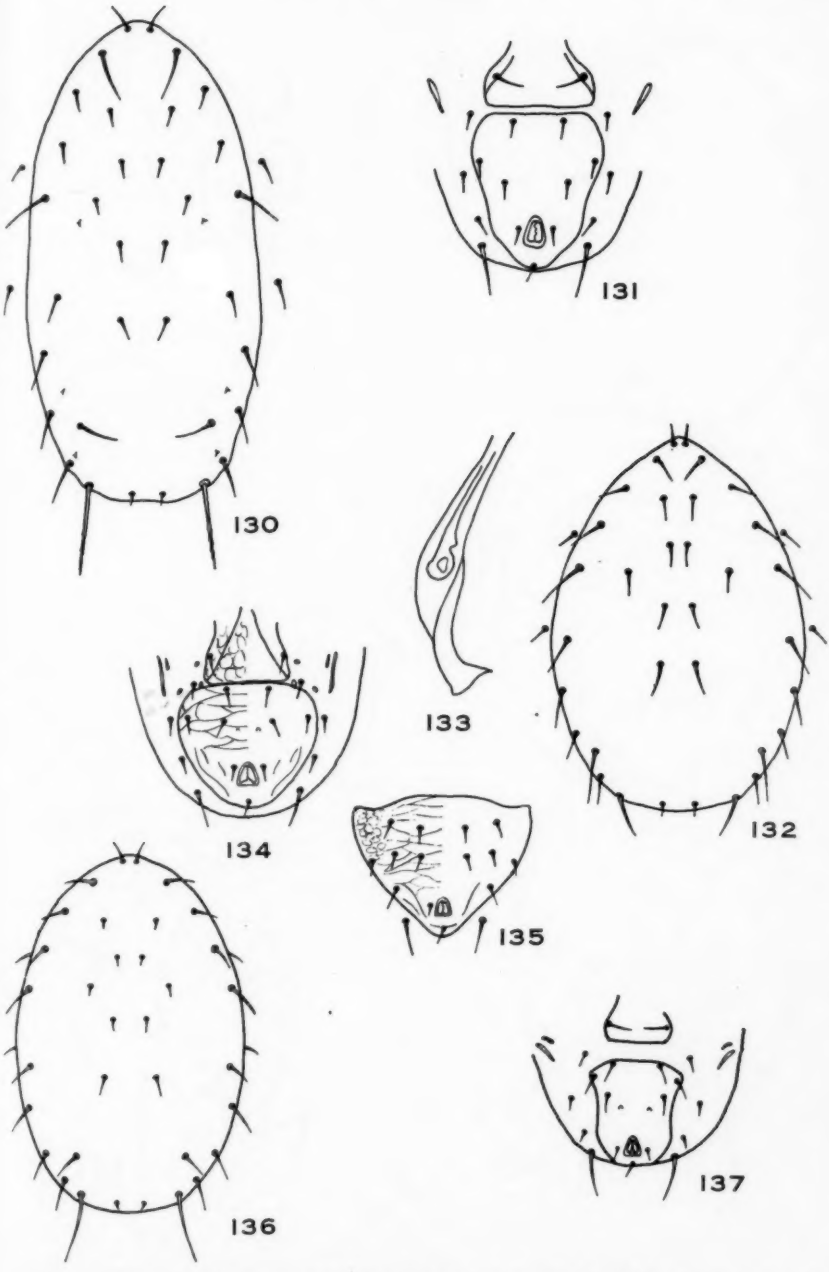
Figs. 112-117. *Typhlodromus* (*Amblyseius*) spp. 112, 113. *T.* (*A.*) *italicus* sp.n. 112, dorsal surface; 113, posterior ventral surface. 114, 115. *T.* (*A.*) *longispinosus* Evans. 114, dorsal surface; 115, posterior ventral surface. 116, 117. *T.* (*A.*) *fallacis* (Garman). 116, dorsal surface; 117, posterior ventral surface.



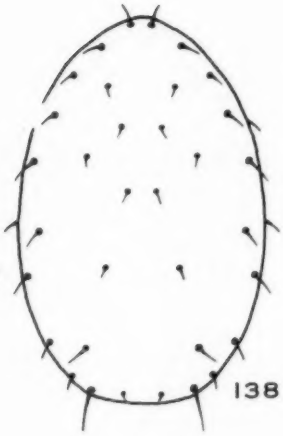
Figs. 118-123. *Typhlodromus* (*Amblyseius*) spp. 118, 119. *T.* (*A.*) *masseei* Nesbitt. 118, dorsal surface; 119, posterior ventral surface. 120, 121. *T.* (*A.*) *bellinus* Womersley. 120, dorsal surface; 121, posterior ventral surface. 122, 123. *T.* (*A.*) *umbraticus* Chant. 122, dorsal surface; 123, posterior ventral surface.

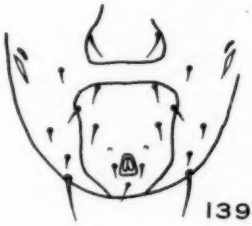


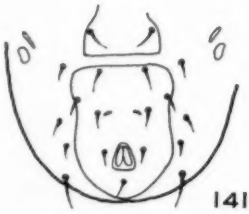
Figs. 124-129. *Typhlodromus* (*Amblyseius*) spp. 124, 125. *T.* (*A.*) ***desertus*** Chant. 124, dorsal surface; 125, posterior ventral surface. 126, 127. *T.* (*A.*) ***scoticus*** Collyer. 126, dorsal surface; 127, posterior ventral surface. 128, 129. *T.* (*A.*) ***reticulatus*** Oudemans. 128, dorsal surface; 129, posterior ventral surface.

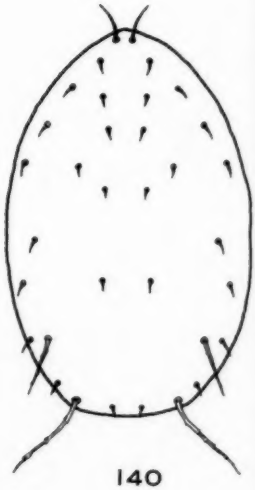


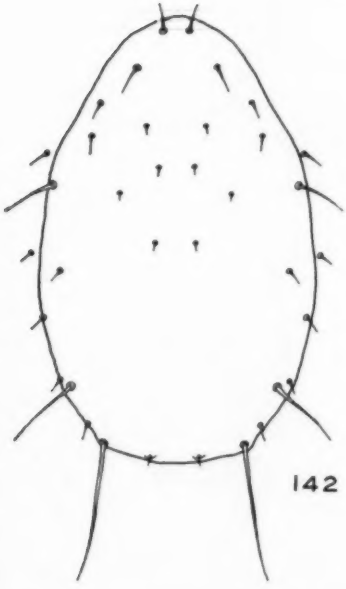
Figs. 130-137. *Typhlodromus* (*Amblyseius*) spp. 130, 131. *T.* (*A.*) *amicus* sp.n. 130, dorsal surface; 131, posterior ventral surface. 132-135. *T.* (*A.*) *novaescotiae* sp.n. 132, dorsal surface; 133, peritreme; 134, posterior ventral surface; 135, male, ventrianal shield. 136, 137. *T.* (*A.*) *cucumeris* Oudemans. 136, dorsal surface; 137, posterior ventral surface.

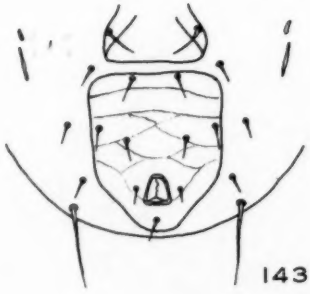




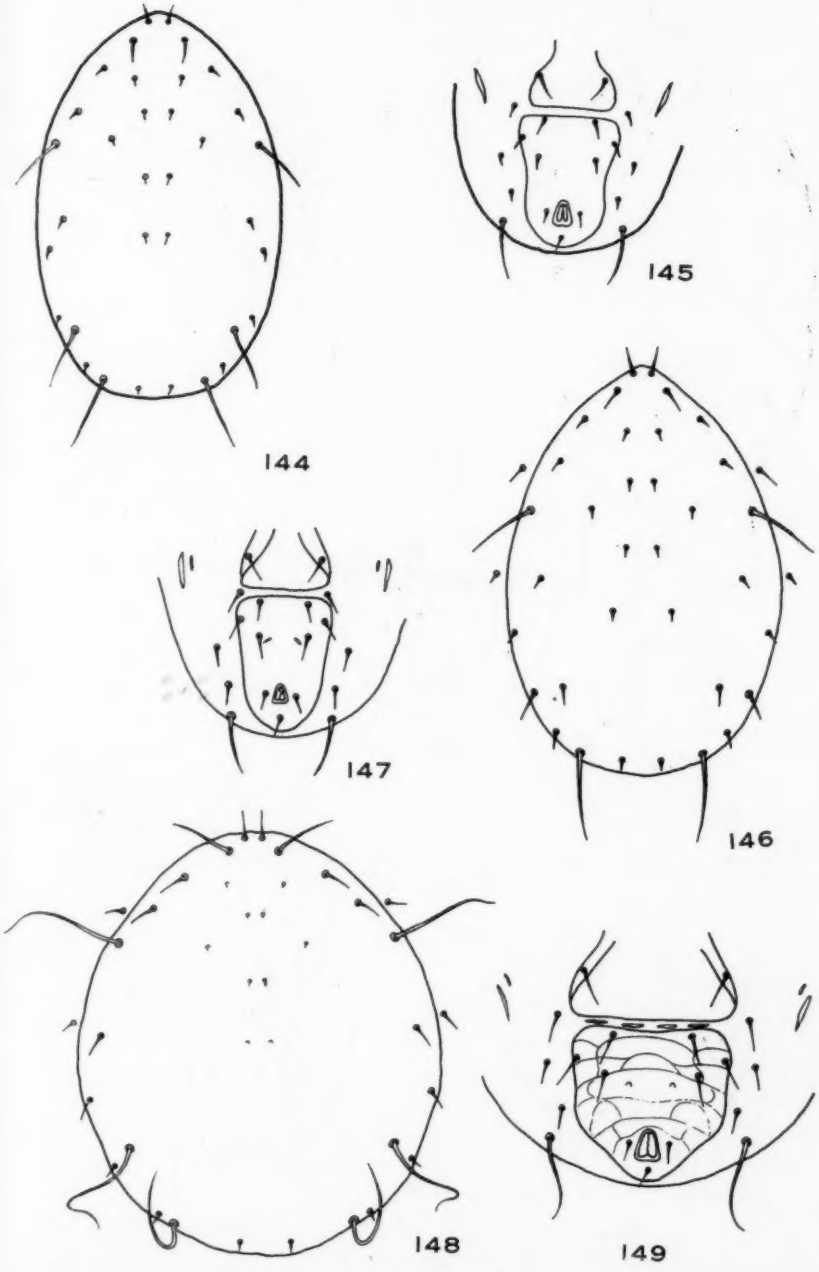




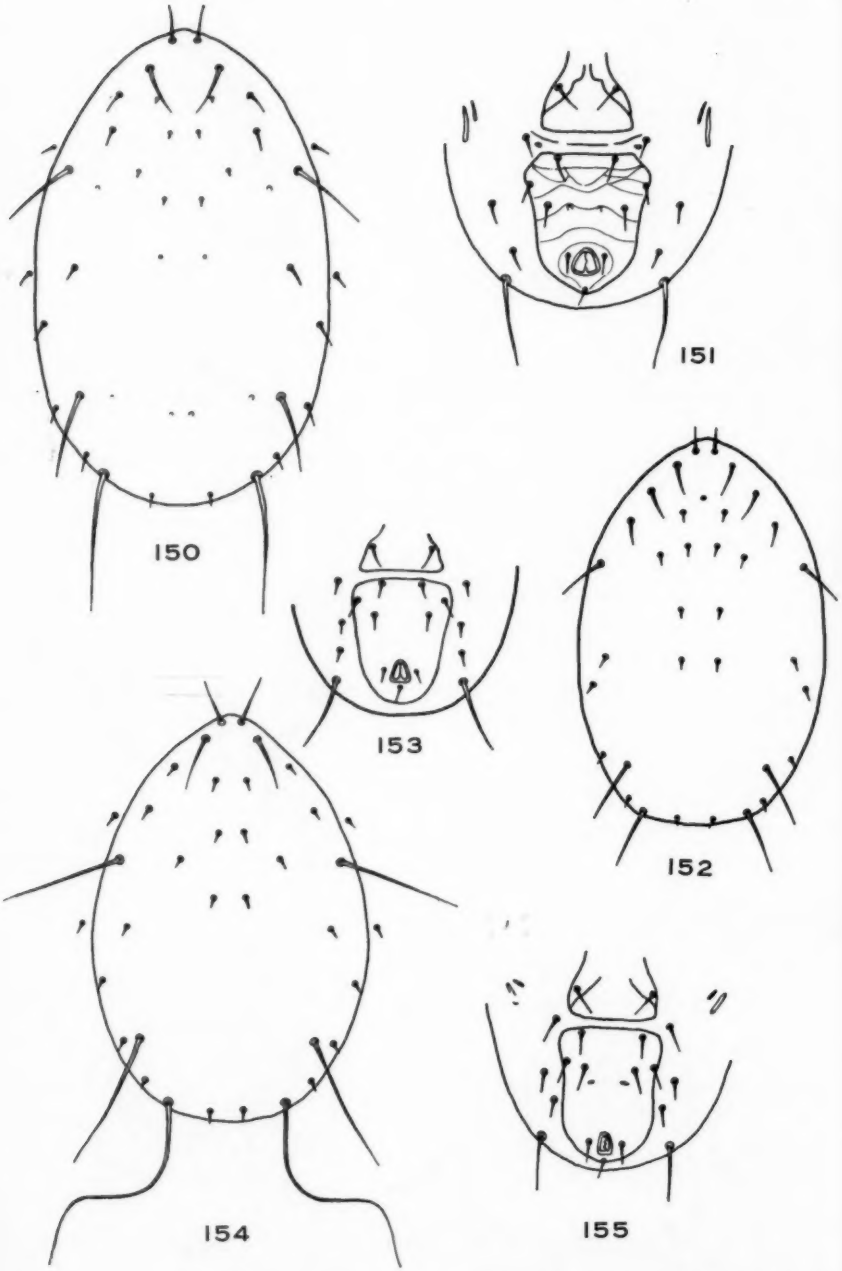




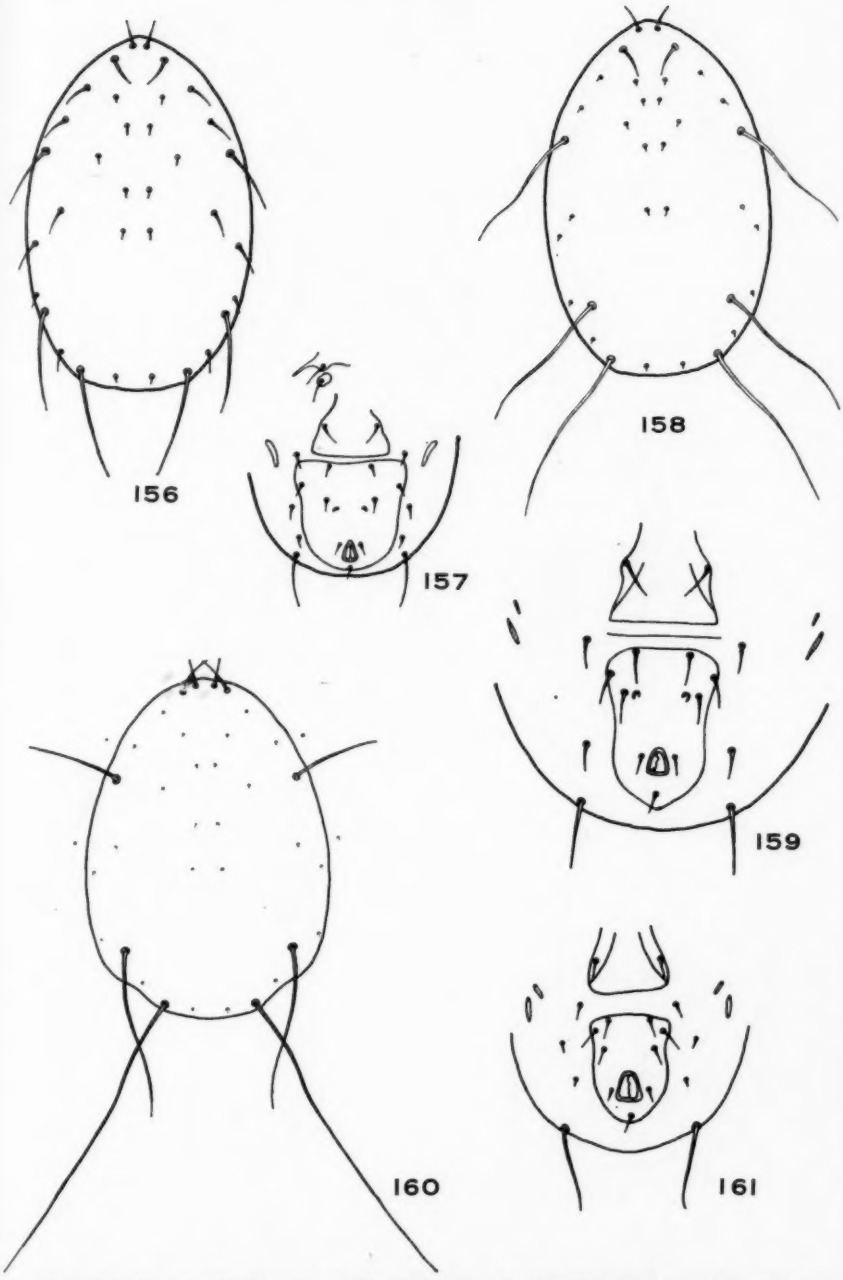
Figs. 138-143. *Typhlodromus* (*Amblyseius*) spp. 138, 139. *T.* (*A.*) ***marinus*** (Willmann). 138, dorsal surface; 139, posterior ventral surface. 140, 141. *T.* (*A.*) ***asiaticus*** Evans. 140, dorsal surface; 141, posterior ventral surface. 142, 143. *T.* (*A.*) ***asetus*** **sp.n.** 142, dorsal surface; 143, posterior ventral surface.



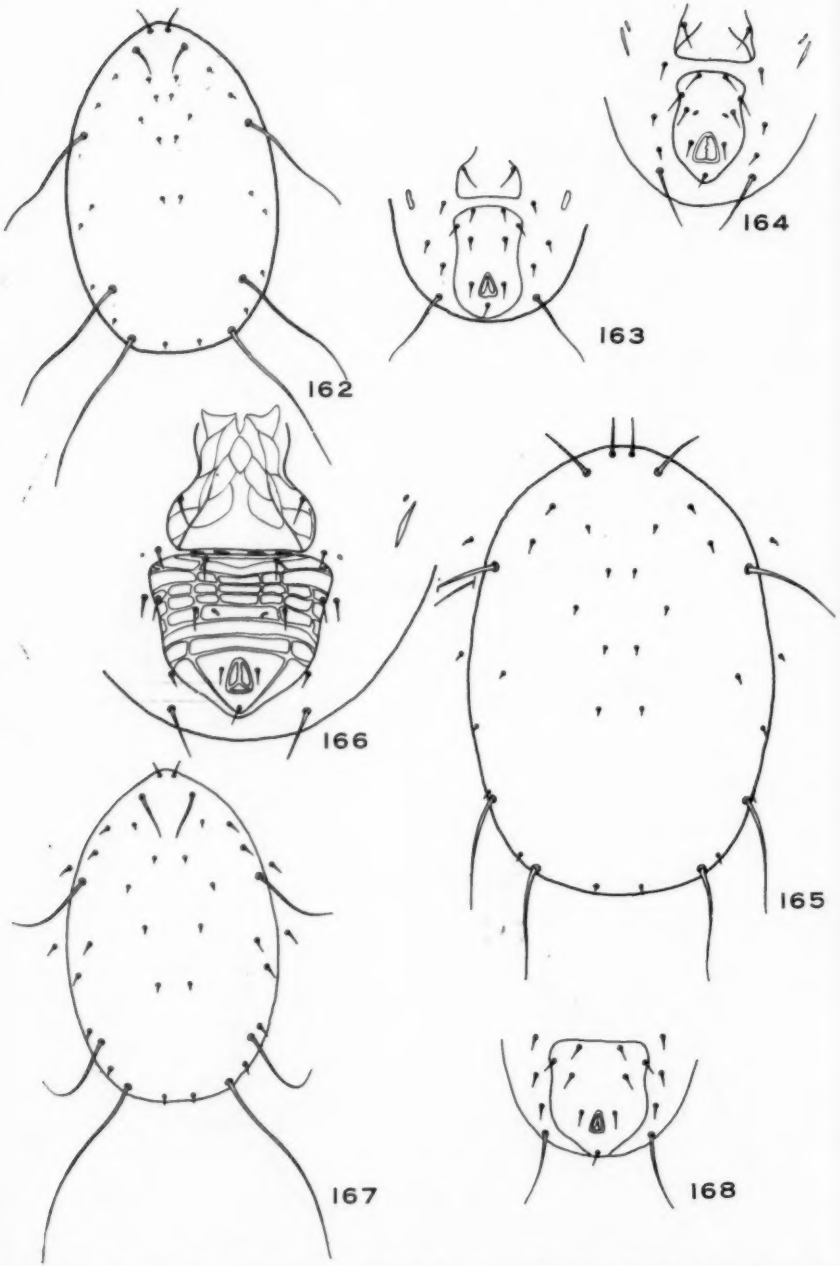
Figs. 144-149. *Typhlodromus* (*Amblyseius*) spp. 144, 145. *T.* (*A.*) *callunae* (Willmann) comb. n. 144, dorsal surface; 145, posterior ventral surface. 146, 147. *T.* (*A.*) *garmani* nom. n. 146, dorsal surface; 147, posterior ventral surface. 148, 149. *T.* (*A.*) *rosellus* sp.n. 148, dorsal surface; 149, posterior ventral surface.



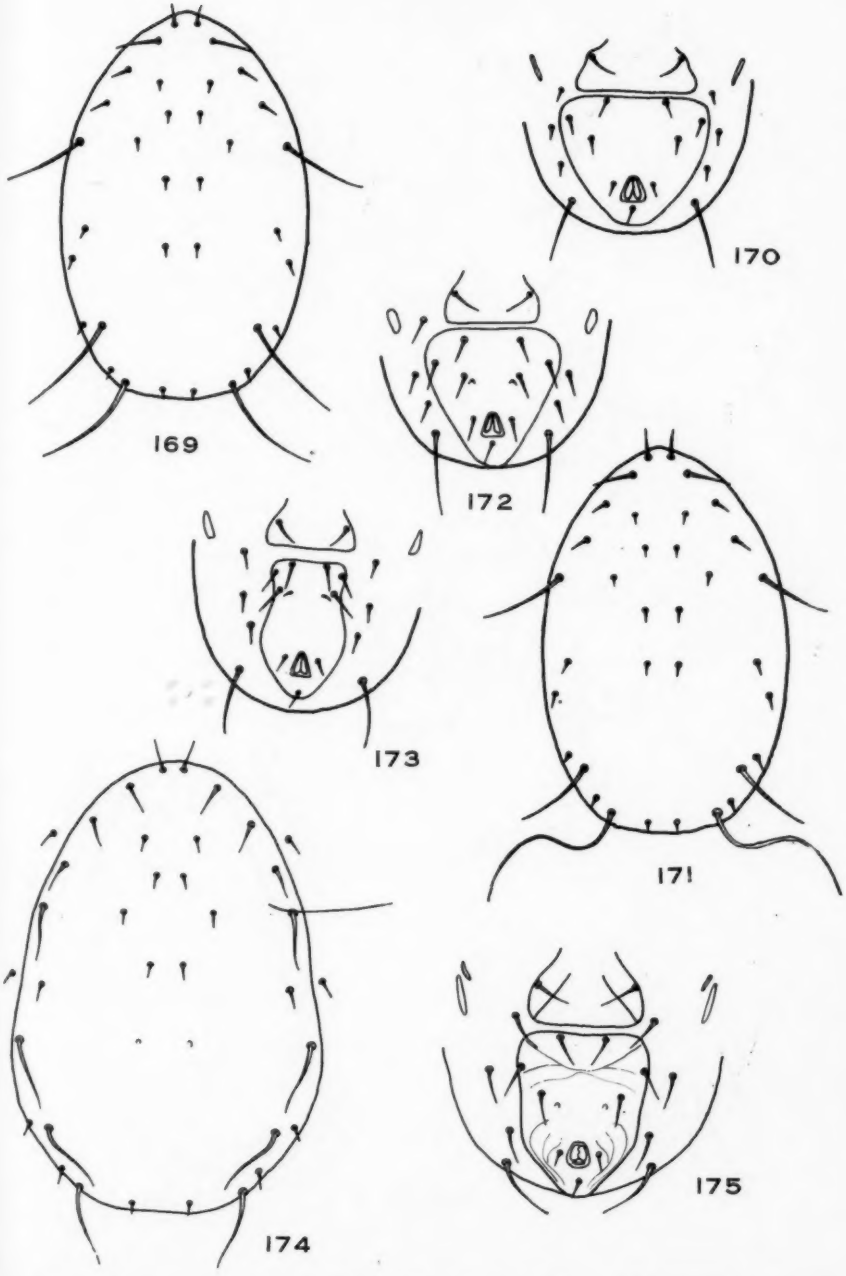
Figs. 150-155. *Typhlodromus* (*Amblyseius*) spp. 150, 151. *T.* (*A.*) ***lepidus*** sp.n. 150, dorsal surface; 151, posterior ventral surface. 152, 153. *T.* (*A.*) ***aequipilus*** (Berlese). 152, dorsal surface; 153, posterior ventral surface. 154, 155. *T.* (*A.*) ***guatemalensis*** nom. n. 154, dorsal surface; 155, posterior ventral surface.



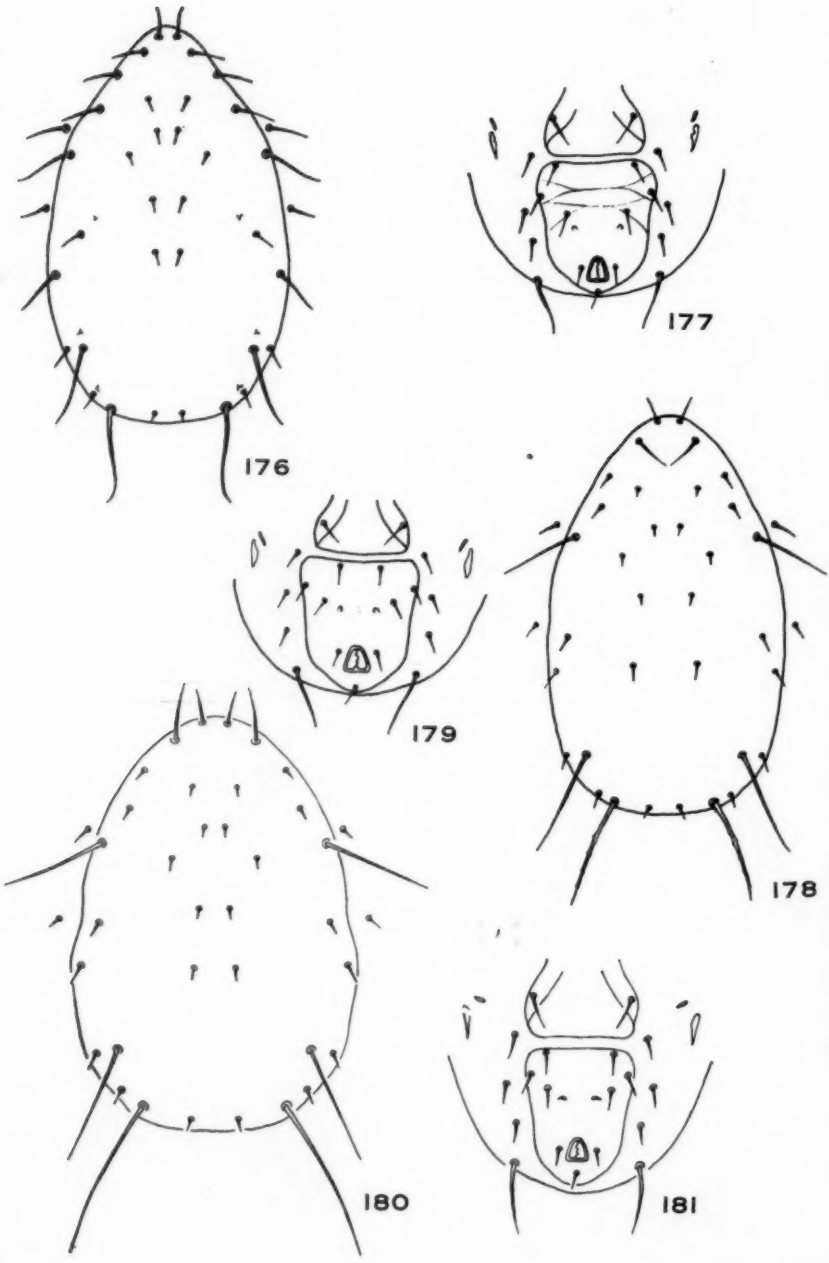
Figs. 156-161. *Typhlodromus* (*Amblyseius*) spp. 156, 157. *T.* (*A.*) *fraterculus* (Berlese). 156, dorsal surface; 157, posterior ventral surface. 158, 159. *T.* (*A.*) *krantzi* nom. n. 158, dorsal surface; 159, posterior ventral surface. 160, 161. *T.* (*A.*) *multidentatus* sp.n. 160, dorsal surface; 161, posterior ventral surface.



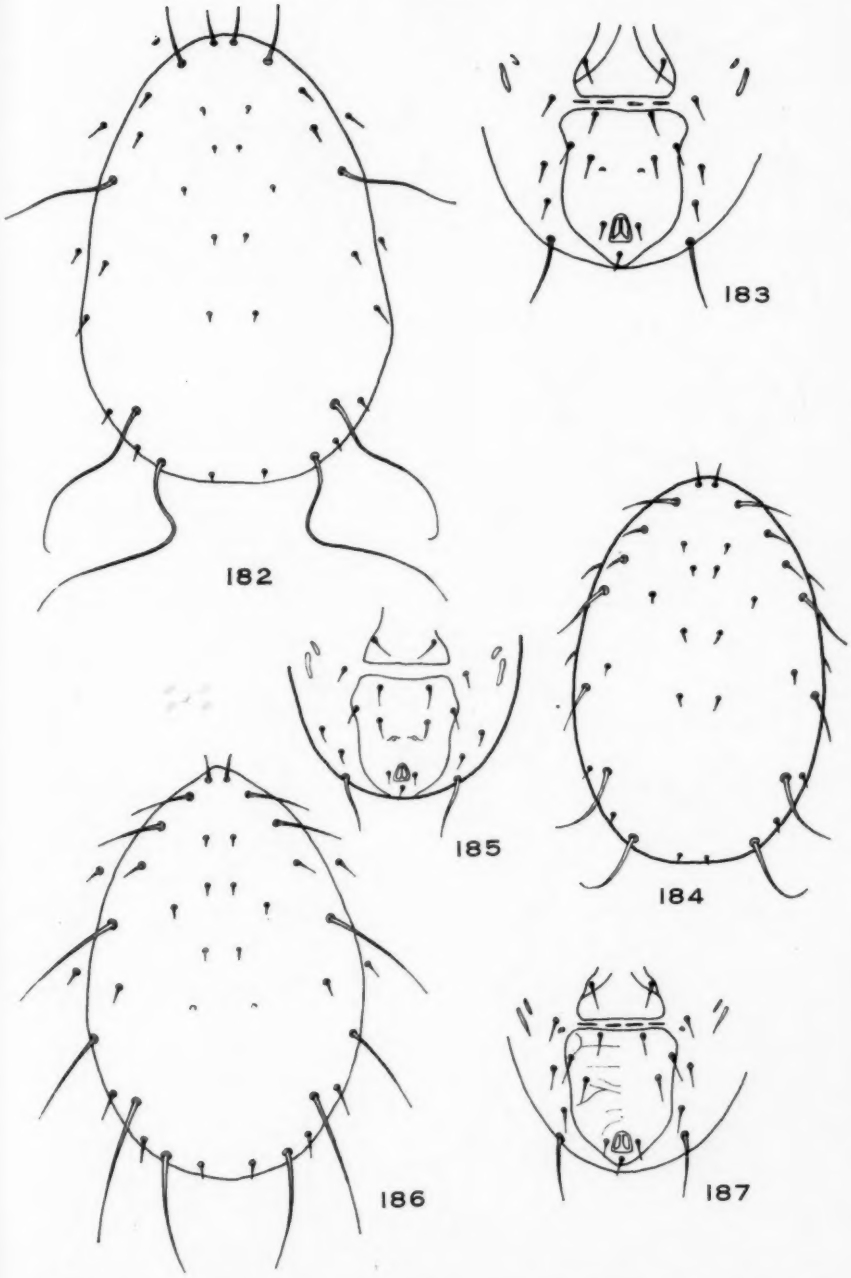
Figs. 162-168. *Typhlodromus* (*Amblyseius*) spp. 162, 163. *T.* (*A.*) *perlongisetus* (Berlese). 162, dorsal surface; 163, posterior ventral surface. 164. *T.* (*A.*) *herbicolus* sp.n., posterior ventral surface. 165, 166. *T.* (*A.*) *morgani* Chant. 165, dorsal surface; 166, posterior ventral surface. 167, 168. *T.* (*A.*) *floridanus* (Muma) comb. n. 167, dorsal surface; 168, posterior ventral surface.



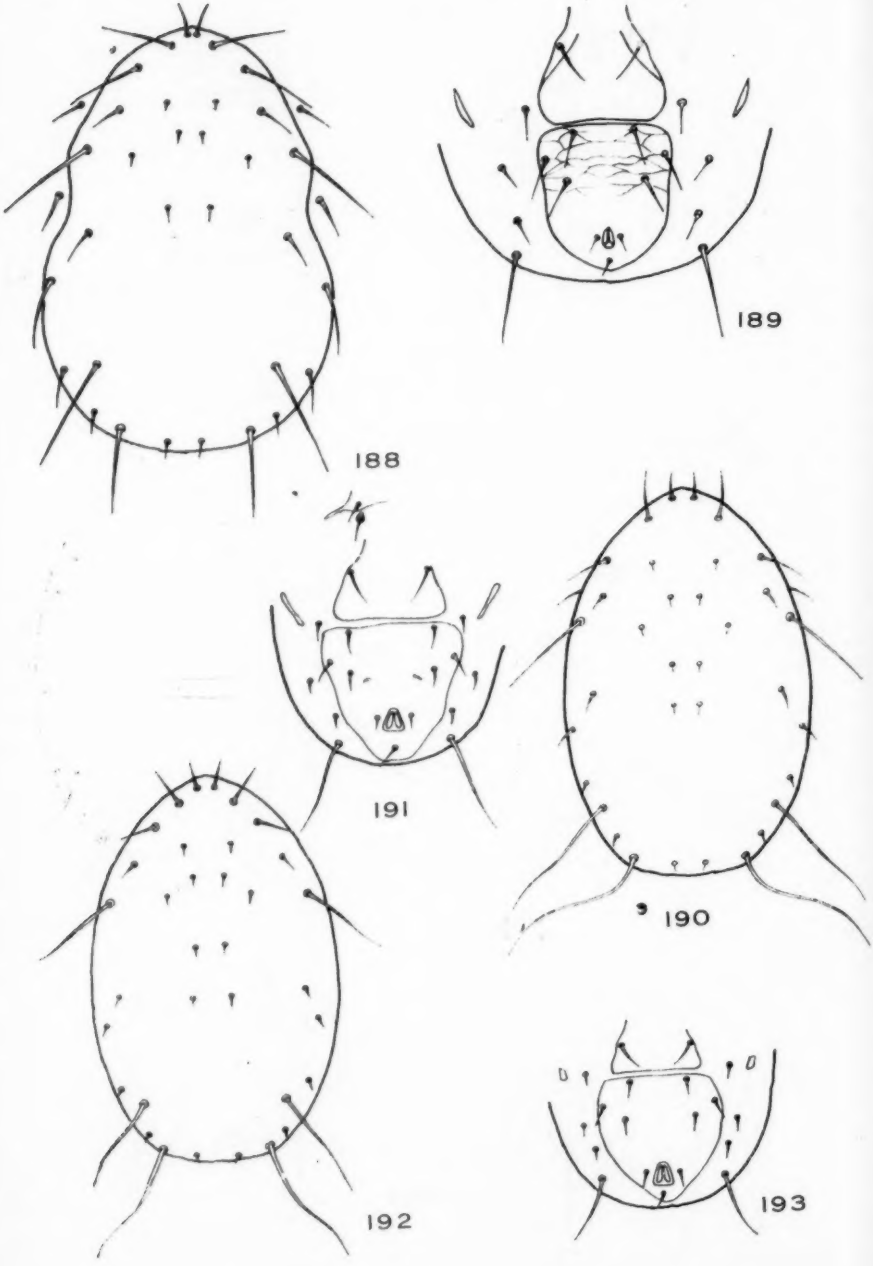
Figs. 169-175. *Typhlodromus* (*Amblyseius*) spp. 169, 170. *T.* (*A.*) *longulus* (Berlese). 169, dorsal surface; 170, posterior ventral surface. 171-173. *T.* (*A.*) *caudatus* (Berlese). 171, dorsal surface; 172, 173, posterior ventral surfaces. 174, 175. *T.* (*A.*) *lichenis* sp.n. 174, dorsal surface; 175, posterior ventral surface.



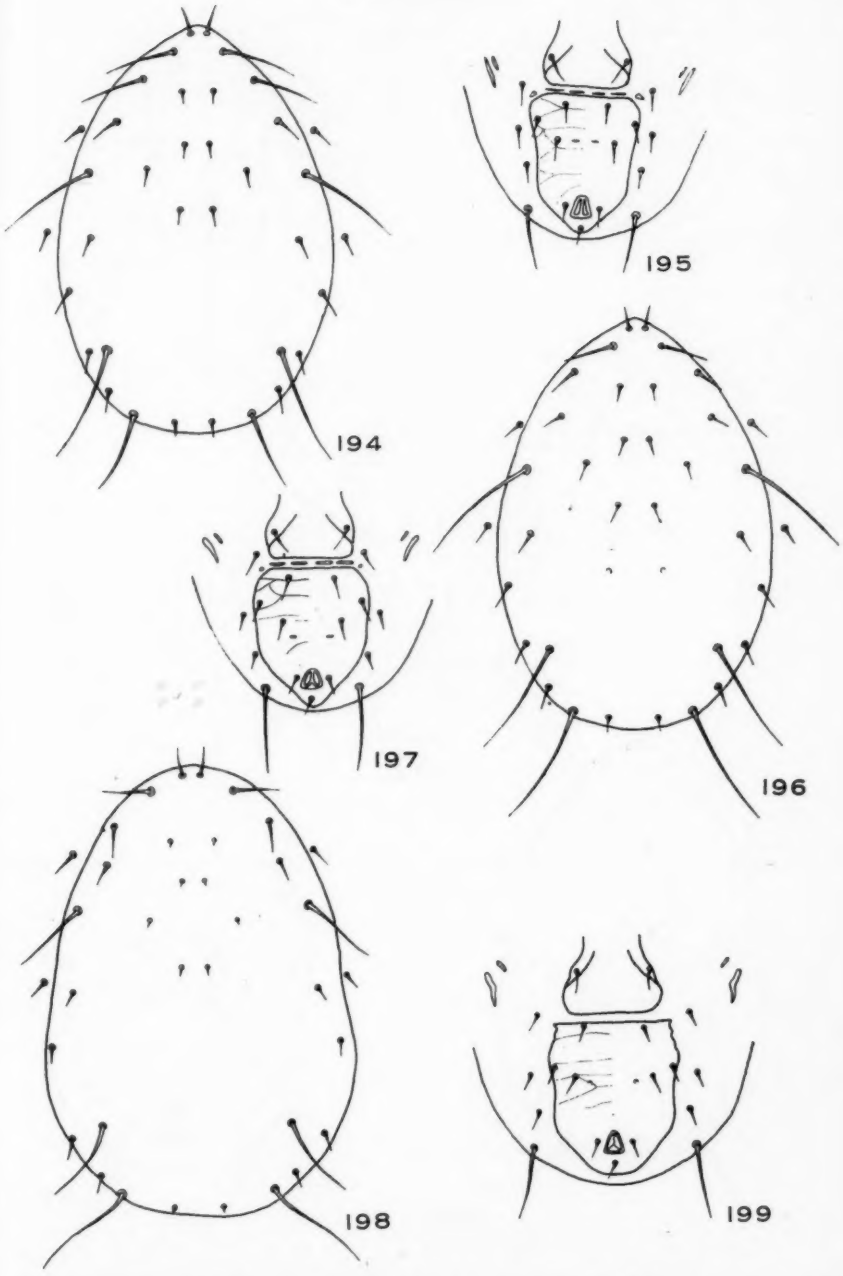
Figs. 176-181. *Typhlodromus* (*Amblyseius*) spp. 176, 177. *T.* (*A.*) *collyerae* sp.n. 176, dorsal surface; 177, posterior ventral surface. 178, 179. *T.* (*A.*) *britannicus* sp.n. 178, dorsal surface; 179, posterior ventral surface. 180, 181. *T.* (*A.*) *aerialis* (Muma) comb. n. 180, dorsal surface; 181, posterior ventral surface.



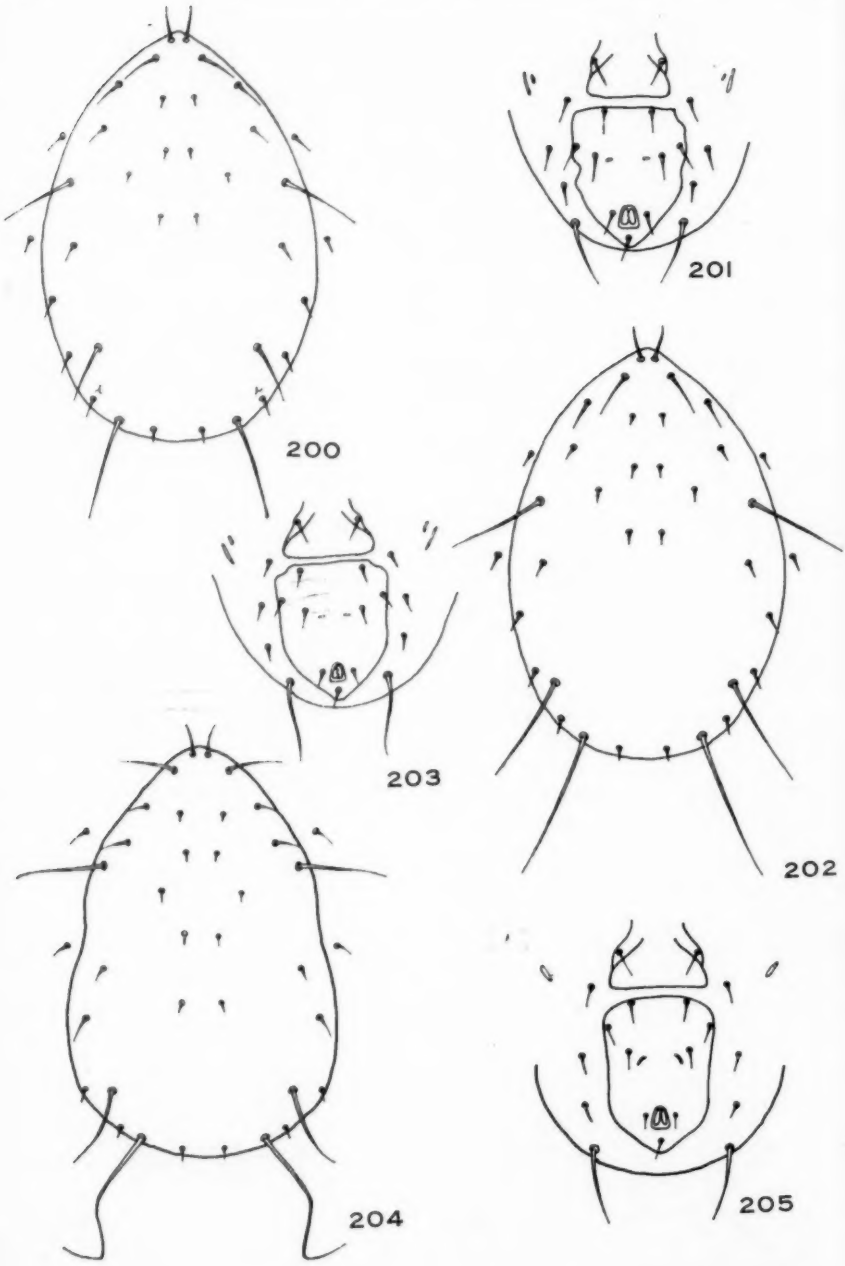
Figs. 182-187. *Typhlodromus* (*Amblyseius*) spp. 182, 183. *T.* (*A.*) *schusteri* sp.n. 182, dorsal surface; 183, posterior ventral surface. 184, 185. *T.* (*A.*) *graminis* (Chant) comb. n. 184, dorsal surface; 185, posterior ventral surface. 186, 187. *T.* (*A.*) *neomexicanus* nom. n. 186, dorsal surface; 187, posterior ventral surface.



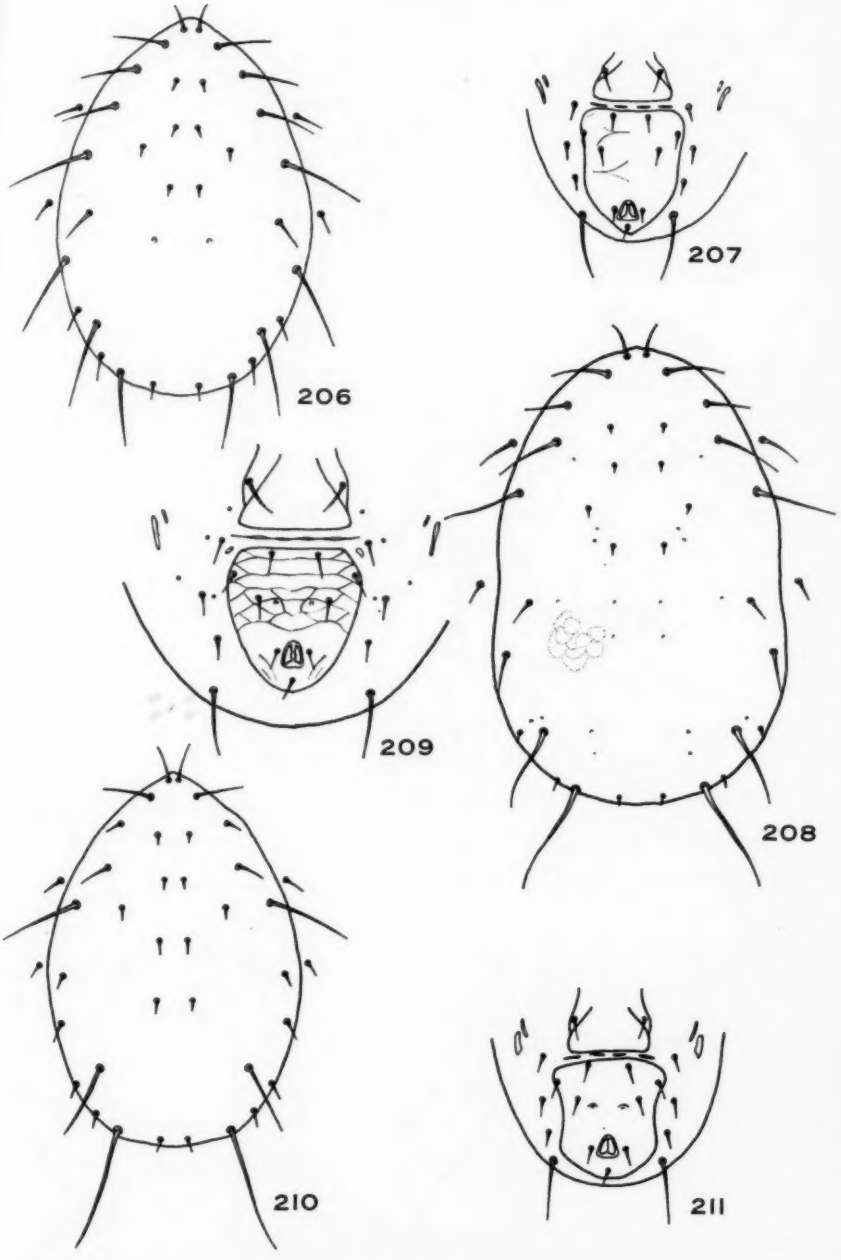
Figs. 188-193. *Typhlodromus* (*Amblyseius*) spp. 188, 189. *T.* (*A.*) *fragariae* (Kennett) comb. n. 188, dorsal surface; 189, posterior ventral surface. 190, 191. *T.* (*A.*) *foenalis* (Berlese). 190, dorsal surface; 191, posterior ventral surface. 192, 193. *T.* (*A.*) *obtusus* (Koch). 192, dorsal surface; 193, posterior ventral surface.



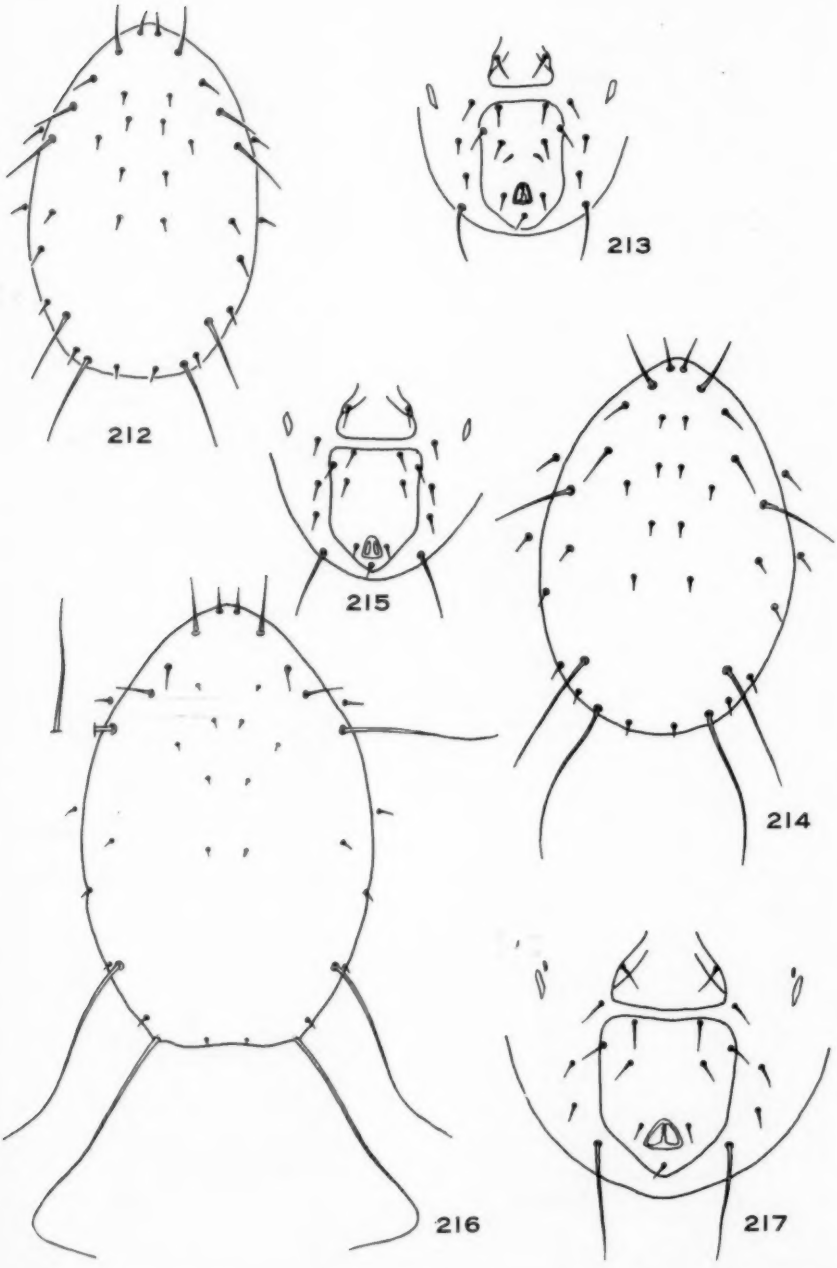
Figs. 194-199. *Typhlodromus* (*Amblyseius*) spp. 194, 195. *T.* (*A.*) *ovatus* (Garman) comb. n. 194, dorsal surface; 195, posterior ventral surface. 196, 197. *T.* (*A.*) *oregonensis* (Garman) comb. n. 196, dorsal surface; 197, posterior ventral surface. 198, 199. *T.* (*A.*) *putmani* sp.n. 198, dorsal surface; 199, posterior ventral surface.



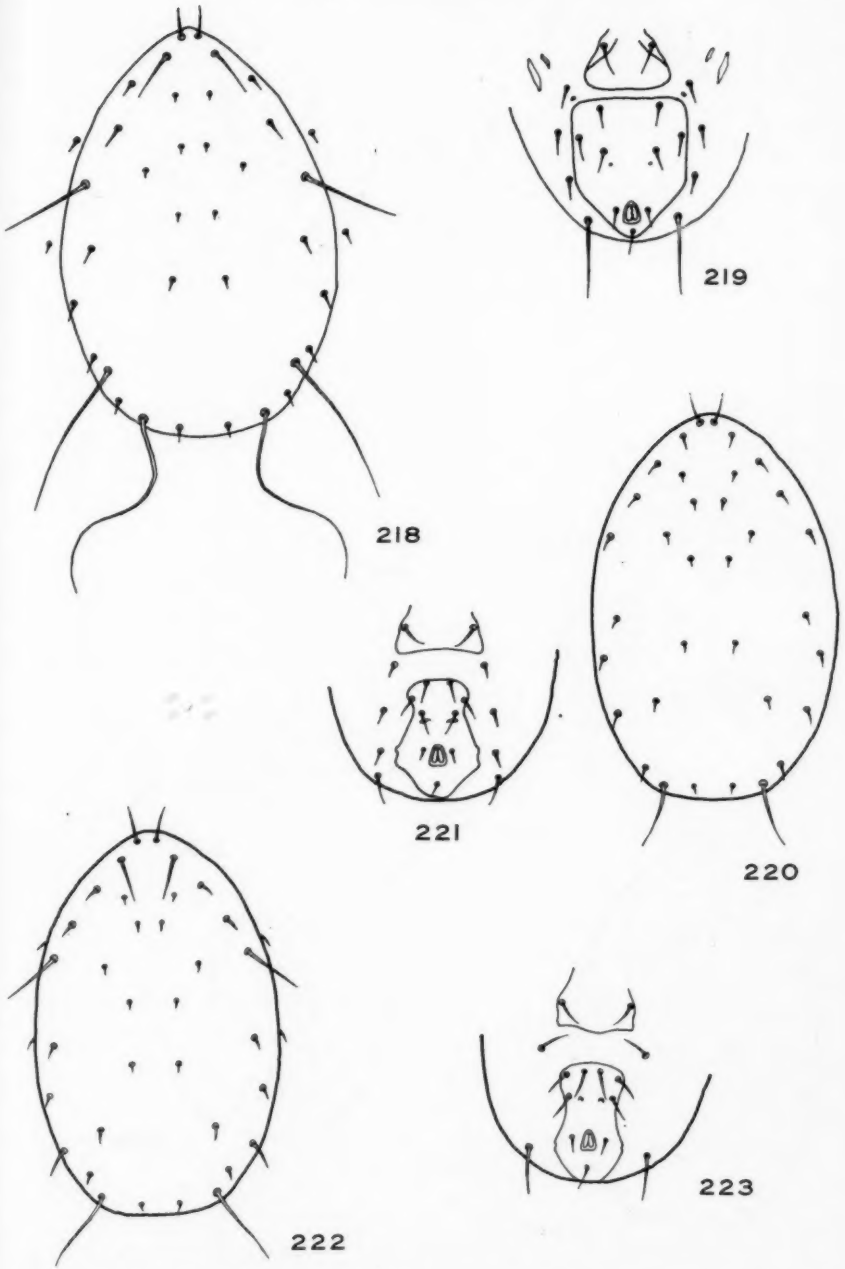
Figs. 200-205. *Typhlodromus* (*Amblyseius*) spp. 200, 201. *T.* (*A.*) *tropicanus* (Garman) comb. n. 200, dorsal surface; 201, posterior ventral surface. 202, 203. *T.* (*A.*) *mexicanus* (Garman) comb. n. 202, dorsal surface; 203, posterior ventral surface. 204, 205. *T.* (*A.*) *andersoni* Chant. 204, dorsal surface; 205, posterior ventral surface.



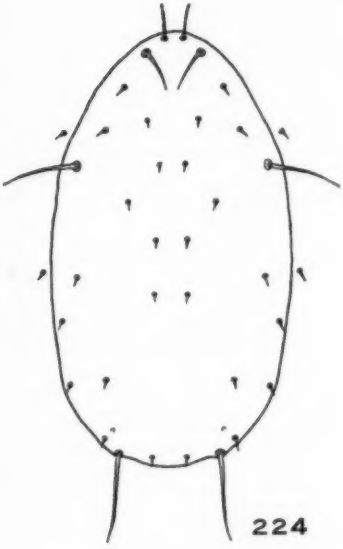
Figs. 206-211. *Typhlodromus* (*Amblyseius*) spp. 206, 207. *T.* (*A.*) *septus* (Garman) comb. n. 206, dorsal surface; 207, posterior ventral surface. 208, 209. *T.* (*A.*) *okanagensis* Chant. 208, dorsal surface; 209, posterior ventral surface. 210, 211. *T.* (*A.*) *potentillae* (Garman) comb. n. 210, dorsal surface; 211, posterior ventral surface.

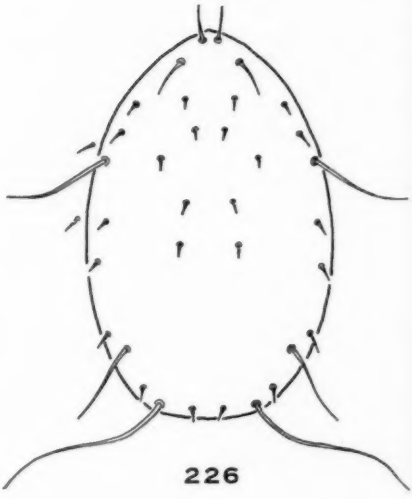


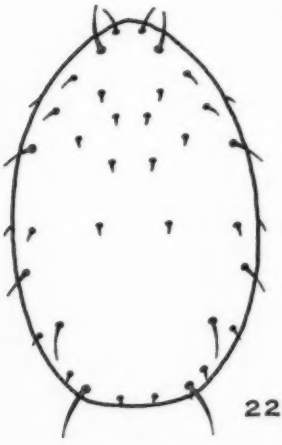
Figs. 212-217. *Typhlodromus* (*Amblyseius*) spp. 212, 213. *T.* (*A.*) *similis* (Koch). 212, dorsal surface; 213, posterior ventral surface. 214, 215. *T.* (*A.*) *americanus* (Garman) comb. n. 214, dorsal surface; 215, posterior ventral surface. 216, 217. *T.* (*A.*) *silvaticus* sp.n. 216, dorsal surface; 217, posterior ventral surface.



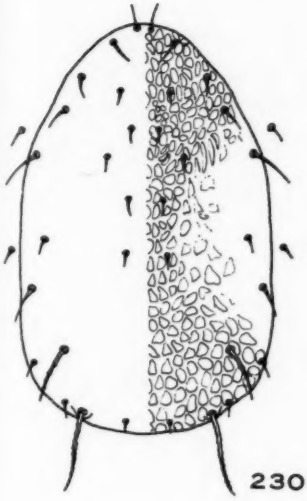
Figs. 218-223. *Typhlodromus* (*Amblyseius*) spp. 218, 219. *T.* (*A.*) *gracilis* (Garman) comb. n. 218, dorsal surface; 219, posterior ventral surface. 220, 221. *T.* (*A.*) *newsami* Evans. 220, dorsal surface; 221, posterior ventral surface. 222, 223. *T.* (*A.*) *africanus* Evans. 222, dorsal surface; 223. posterior ventral surface.



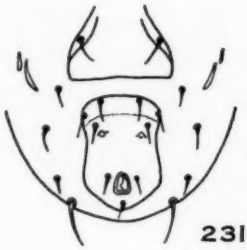




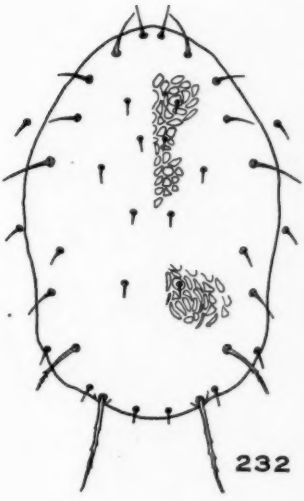
Figs. 224-229. *Typhlodromus* (*Amblyseius*) spp. 224, 225. *T.* (*A.*) *limonicus* (Garman and McGregor) comb. n. 224, dorsal surface; 225, posterior ventral surface. 226, 227. *T.* (*A.*) *largoensis* (Muma) comb. n. 226, dorsal surface; 227, posterior ventral surface. 228, 229. *T.* (*A.*) *peregrinus* Muma. 228, dorsal surface; 229, posterior ventral surface.



230

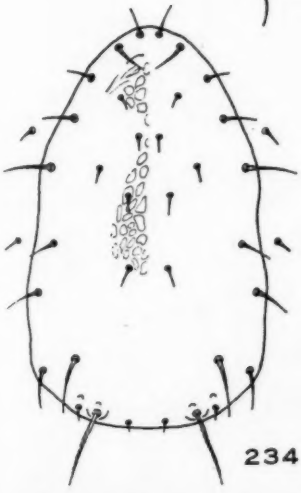


231

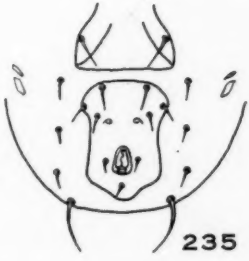


232

233

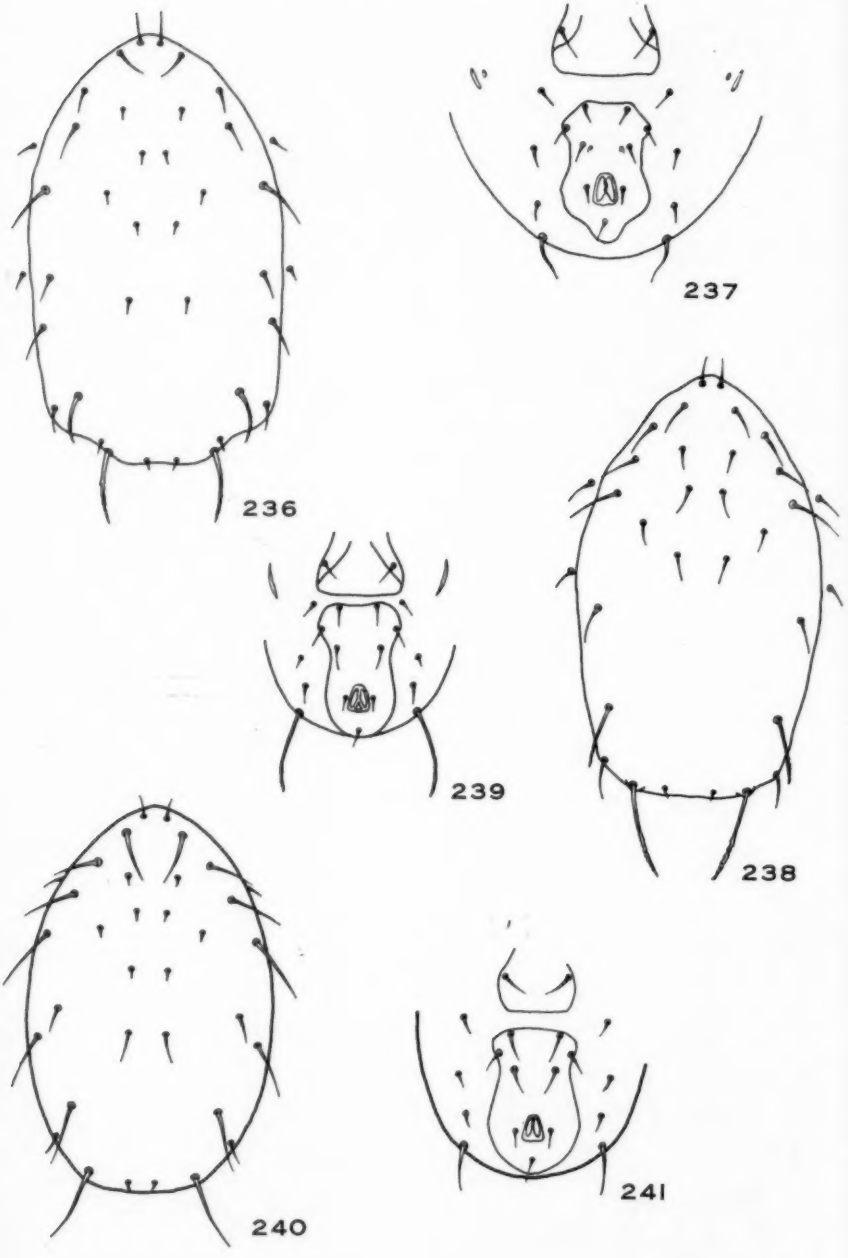


234

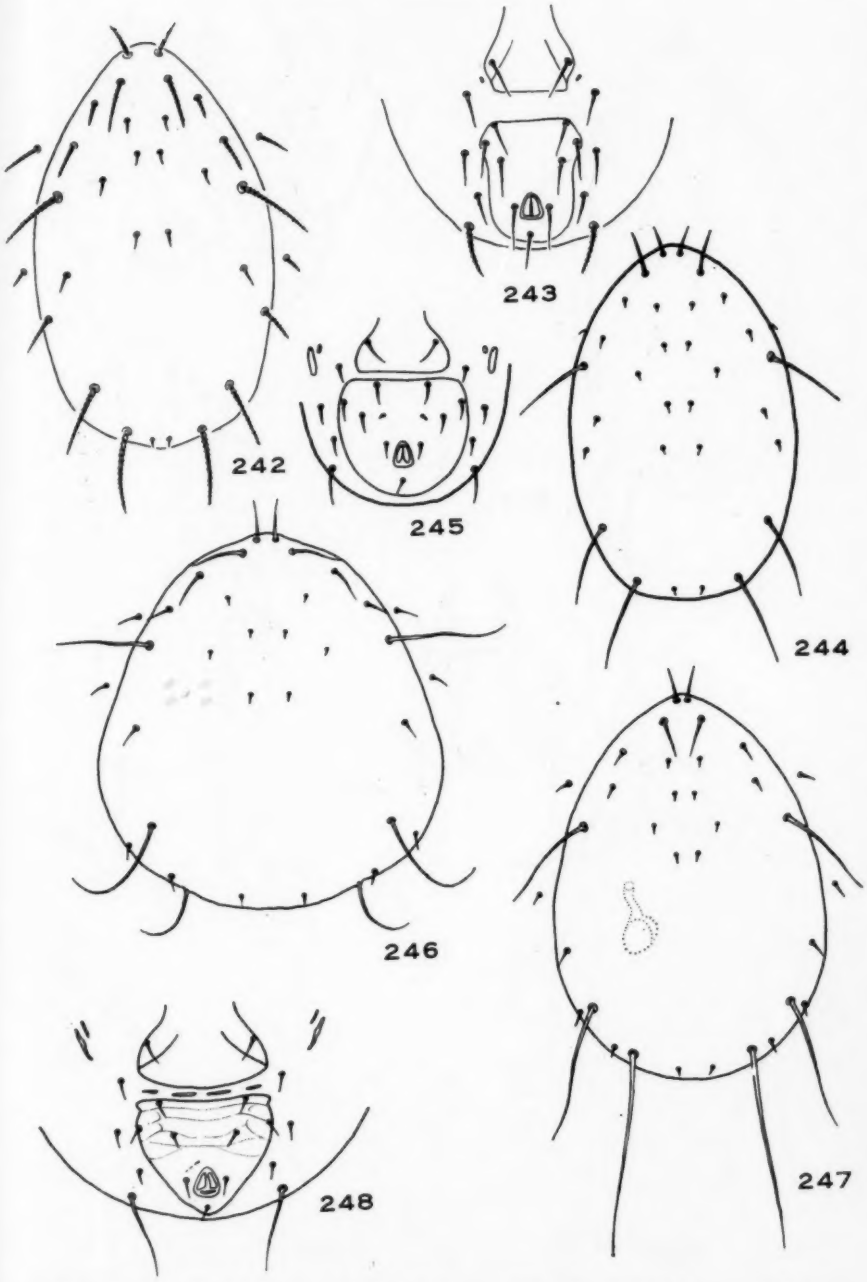


235

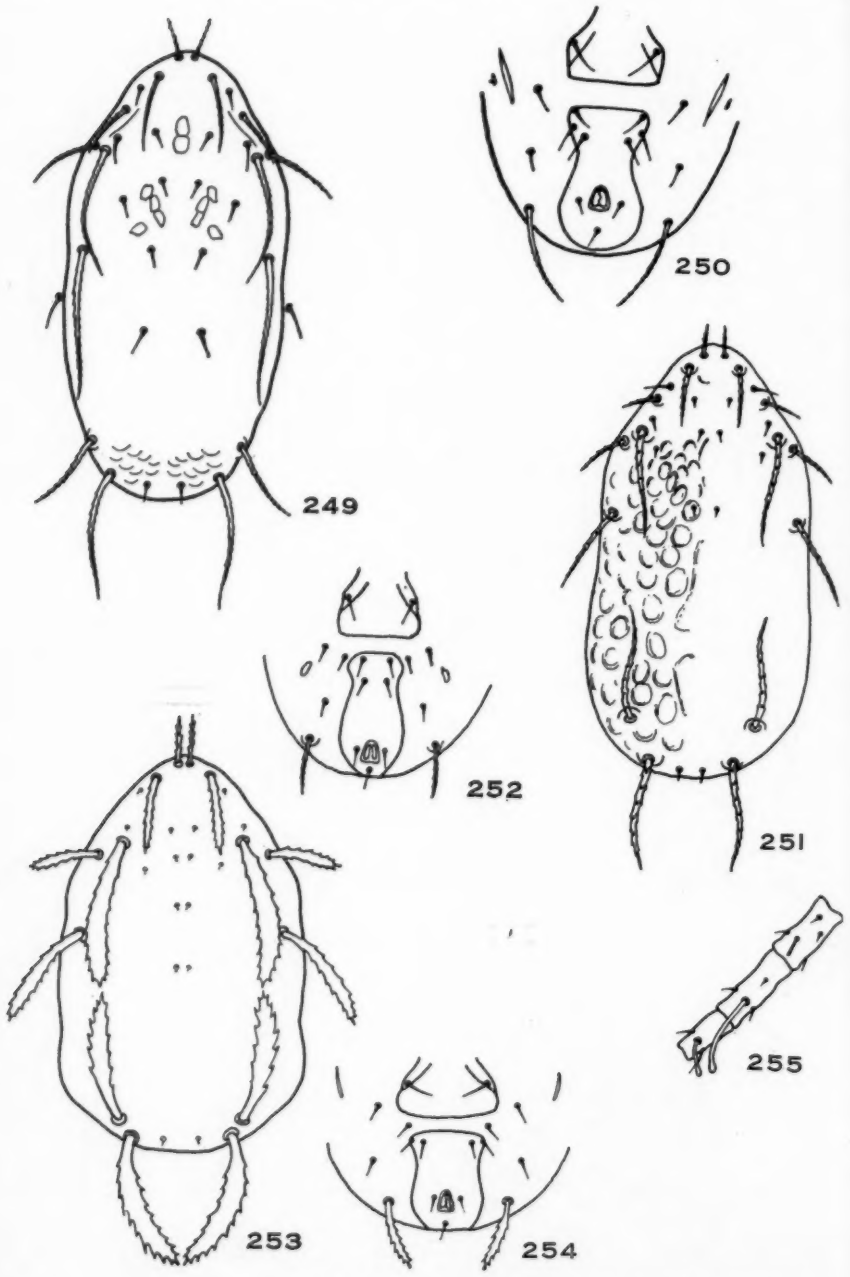
Figs. 230-235. *Typhlodromus* (*Amblyseius*) spp. 230, 231. *T.* (*A.*) *jucundus* sp.n. 230, dorsal surface; 231, posterior ventral surface. 232, 233. *T.* (*A.*) *robiniae* sp.n. 232, dorsal surface; 233, posterior ventral surface. 234, 235. *T.* (*A.*) *evansi* sp.n. 234, dorsal surface; 235, posterior ventral surface.



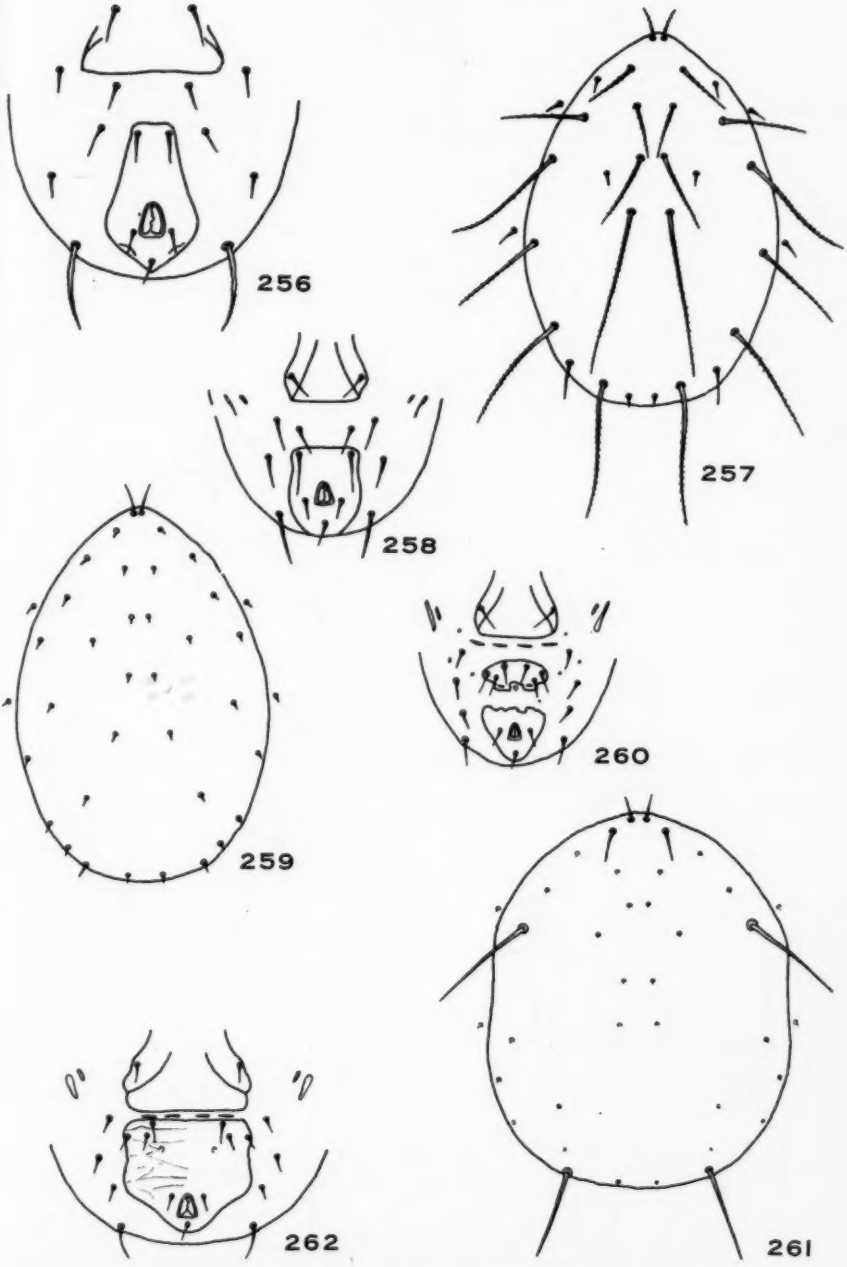
Figs. 236-241. *Typhlodromus* (*Amblyseius*) spp. 236, 237. *T.* (*A.*) *primulae* sp.n. 236, dorsal surface; 237, posterior ventral surface. 238, 239. *T.* (*A.*) *oudemansi* sp.n. 238, dorsal surface; 239, posterior ventral surface. 240, 241. *T.* (*A.*) *aberrans* Oudemans 240, dorsal surface; 241, posterior ventral surface.



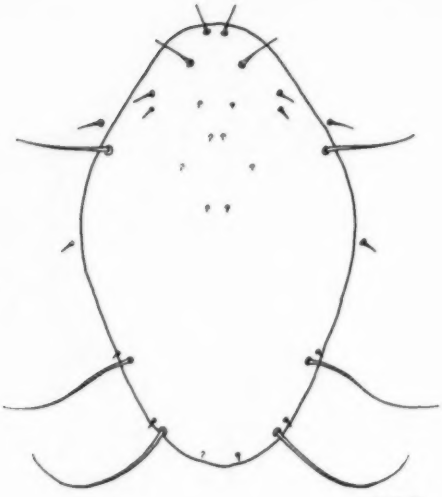
Figs. 242-248. *Typhlodromus* (*Amblyseius*) spp. 242, 243. *T.* (*A.*) *heveae* Oudemans. 242, dorsal surface; 243, posterior ventral surface. 244, 245. *T.* (*A.*) *grandis* (Berlese). 244, dorsal surface; 245, posterior ventral surface. 246. *T.* (*A.*) *sandersi* sp.n., dorsal shield. 247, 248. *T.* (*A.*) *terrestris* sp.n. 247, dorsal surface; 248, posterior ventral surface.

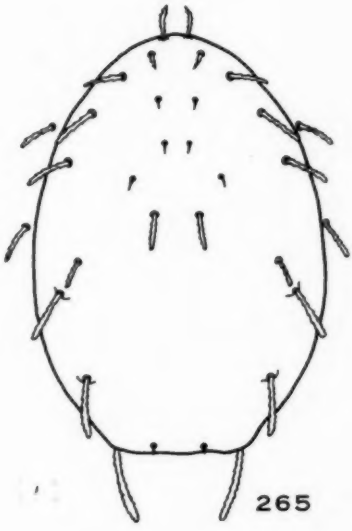


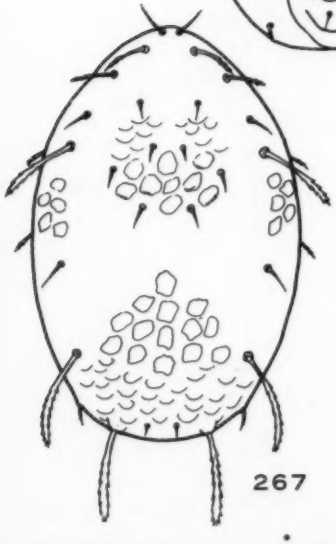
Figs. 249-255. *Phytoseius* spp. 249, 250. *P. plumifer* (Canestrini and Fanzago). 249, dorsal surface; 250, posterior ventral surface. 251, 252. *P. macropilis* (Banks). 251, dorsal surface; 252, posterior ventral surface. 253-255. *P. platypilis* sp.n. 253, dorsal surface; 254, posterior ventral surface; 255, leg IV.

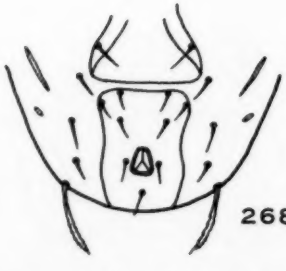


Figs. 256-262. Phytoseiidae. 256. *Phytoseius bakeri* sp.n., posterior ventral surface. 257, 258. *Phytoseiulus macropilis* (Banks). 257, dorsal surface; 258, posterior ventral surface. 259, 260. *Iphiseius degenerans* (Berlese). 259, dorsal surface; 260, posterior ventral surface. 261, 262. *I. quadripilis* (Banks) comb. n. 261, dorsal surface; 262, posterior ventral surface.

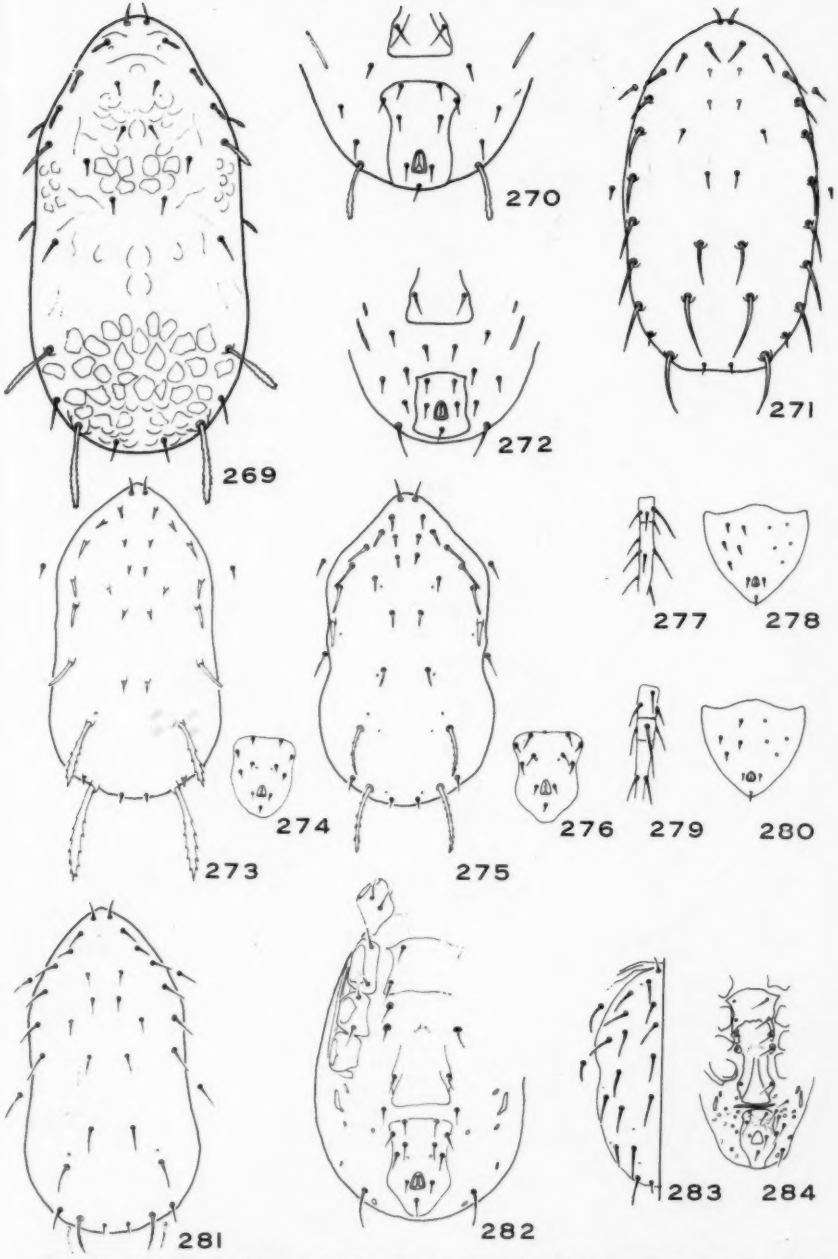




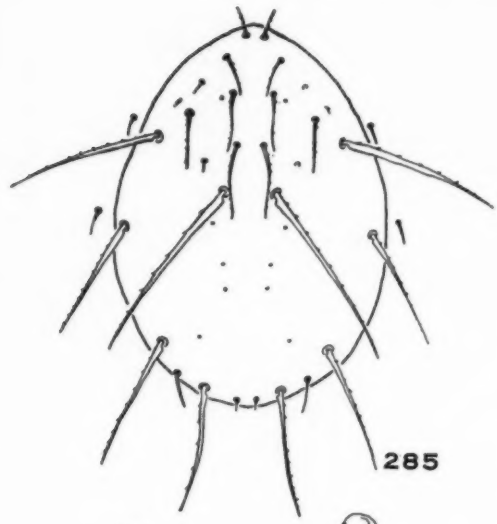


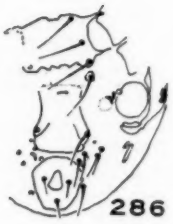


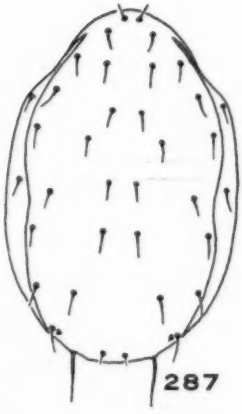
Figs. 263-268. Phytoseiidae. 263, 264. *Iphiseius grovesae* sp. n. 263, dorsal surface; 264, posterior ventral surface 265, 266. *Asperoseius africanus* Chant. 265, dorsal surface; 266, posterior ventral surface. 267, 268. *Proprioseius meridionalis* Chant. 267, dorsal surface; 268, posterior ventral surface.

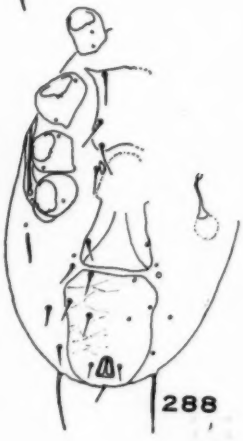


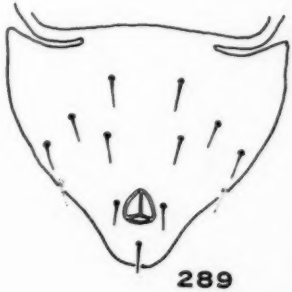
Figs. 269-284. Phytoseiidae. 269, 270. *Proprioseius clancyi* Chant. 269, dorsal surface; 270, posterior ventral surface. 271, 272. *Seiulus simplex* Chant. 271, dorsal surface; 272, posterior ventral surface. 273, 274. *T.* (*T.*) *alveolaris* DeLeon (After DeLeon, 1957). 273, dorsal surface; 274, posterior ventral surface. 275, 276. *T.* (*T.*) *cornus* DeLeon (After DeLeon, 1957). 275, dorsal surface; 276, posterior ventral surface. 277, 278. *T.* (*T.*) *recki* Wainstein (After Wainstein, 1957). 277, leg IV; 278, male, ventrianal shield. *T.* (*T.*) *anchialus* Kennett. 281, dorsal surface; 282, posterior ventral surface. 283, 284. *Seiulus isotrichus* Athias-Henriot (After Athias-Henriot, 1958). 283, dorsal surface; 284, posterior ventral surface.

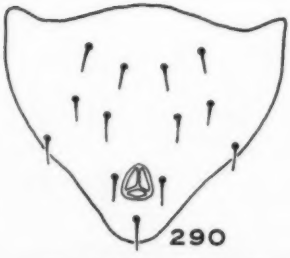




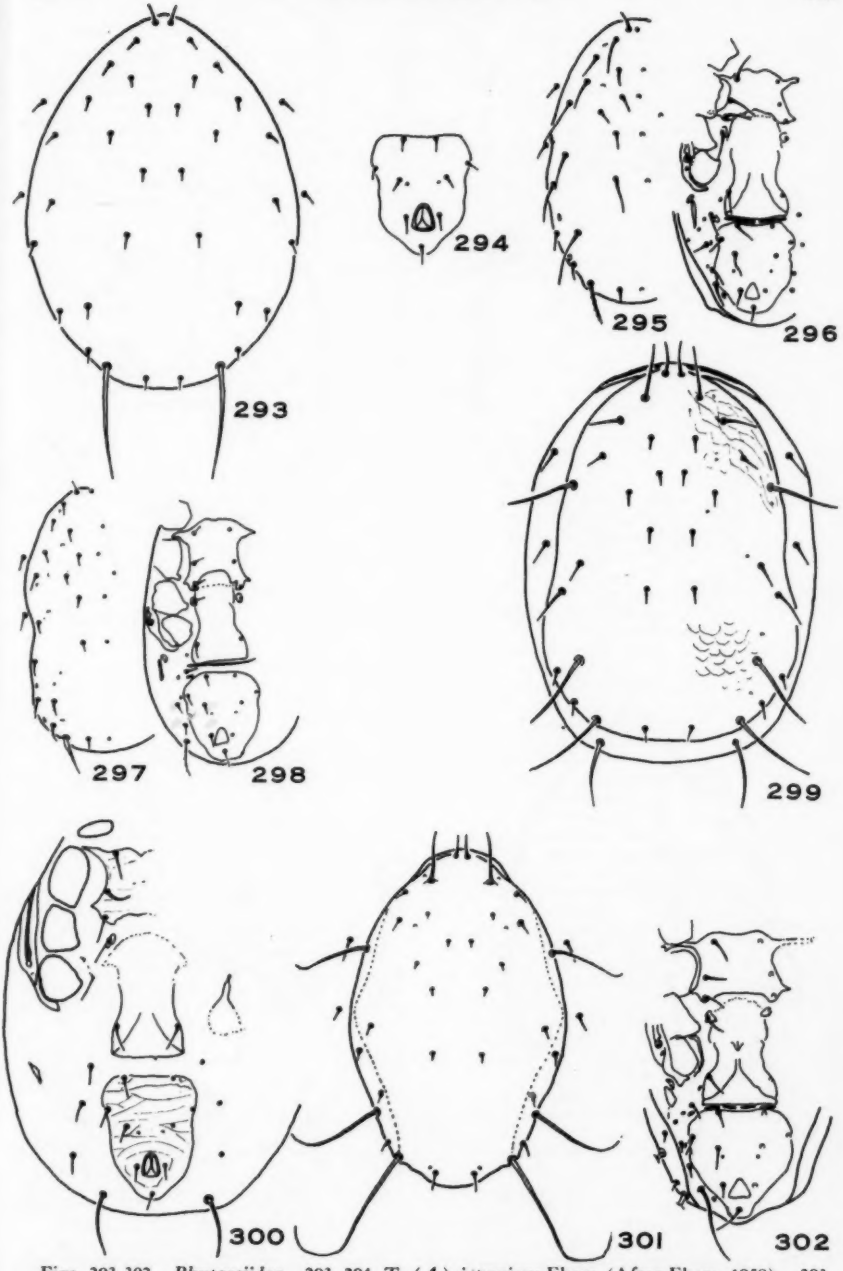




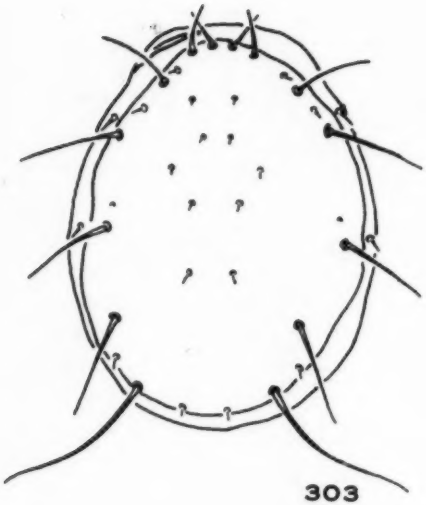




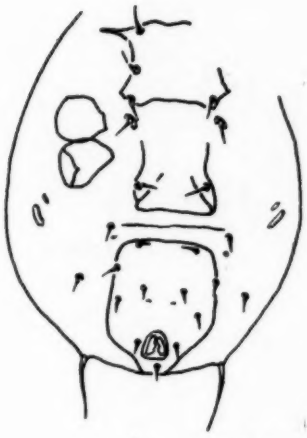
Figs. 285-292. *Phytoseiidae*. 285, 286. *Phytoseiulus persimilis* Athias-Henriot (After Athias-Henriot, 1957a). 285, dorsal surface; 286, posterior ventral surface. 287, 288. *Typhlodromus* (*Amblyseius*) *brevispinus* Kennett. 287, dorsal surface; 288, posterior ventral surface. 289. *T.* (*A.*) *zwoelferi* Dosse, male ventrianal shield (After Dosse, 1957). 290, *T.* (*A.*) *marinus* (Willman), male ventrianal shield. 291, 292. *T.* (*A.*) *paspalivorus* DeLeon (After DeLeon, 1957). 291, dorsal surface; 292, posterior ventral surface.



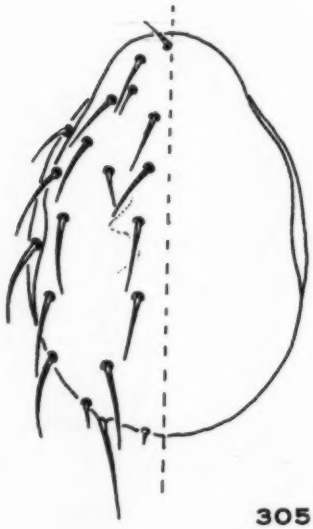
Figs. 293-302. *Phytoseiidae*. 293, 294, *T.* (*A.*) *japonicus* Ehara (After Ehara, 1958). 293, dorsal surface; 294, posterior ventral surface. 295, 296. *T.* (*A.*) *ornatus* Athias-Henriot. (After Athias-Henriot, 1957b). 295, dorsal surface; 296, posterior ventral surface. 297, 298. *T.* (*A.*) *longilaterus* Athias-Henriot (After Athias-Henriot, 1957b). 297, dorsal surface; 298, posterior ventral surface. 299, 300. *T.* (*A.*) *exopodalis* (Kennett) comb. n. 299, dorsal surface; 300, posterior ventral surface. 301, 302. *T.* (*A.*) *meridionalis* (Berlese) comb. n. (After Athias-Henriot, 1958). 301, dorsal surface; 302, posterior ventral surface.



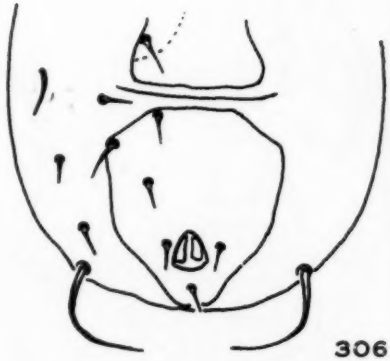
303



304



305



306

Figs. 303-306. *Typhlodromus* (*Typhlodromus*) spp. 303, 304. *T.* (*T.*) *contiguus* Chant. 303, dorsal surface; 304, posterior ventral surface. 305, 306. *T.* (*T.*) *hartlandrowei* Evans (After Evans, 1959). 305, dorsal surface; 306, posterior ventral surface.

INDEX TO GENERA, SPECIES GROUPS, AND SPECIES IN PART II

GENERA:

Asperoseius Chant 111
Iphiseius Berlese 109
Macroseius Chant, Denmark, & Baker 113
Phytoseiulus Evans 108
Phytoseius Ribaga 105
Proprioseius Chant 111
Seiulus Berlese 112
Typhlodromus Scheuten 48
Typhloseiopsis DeLeon 113

SUBGENERA:

Amblyseius Berlese 66
Dubininellus Wainstein 106
Typhlodromus Scheuten 49
Phytoseius Ribaga 105

SPECIES GROUP:

aberrans 100
australicus 66
barkeri 60
conspicuus 50
contiguus 49
finlandicus 67
grandis 102
irregularis 70
newsami 95
obtusus 71
occidentalis 57
pomi 56
rhenanus 62
sandersi 102
setosus 70
sextus 66
smithi 49
soleiger 59
tiliarum 64
validus 55

SPECIES:

T. (A.) aberrans Oudemans 101
T. (T.) aceri Collyer 65
T. (A.) aequipilus (Berlese) 83
T. (A.) aerialis (Muma) comb.nov 88
T. (A.) aferulus sp.n. 69
A. africanus Chant 111
T. (A.) africanus Evans 96
T. (A.) alpinus (Schweizer) comb. nov. 105
T. (A.) alveolaris De Leon 52
T. (A.) americanus (Garman) comb.nov 94
T. (A.) amicus sp.n. 77
T. (T.) anchialus Kennett 51
T. (A.) andersoni Chant 92
T. (A.) arboreus Chant 52
T. (A.) asetus sp.n. 80
T. (A.) asiaticus Evans 80
T. (T.) australicus (Womersley) 66
Phytoseius (D.) bakeri sp.n. 108
T. (T.) bakeri (Garman) 63
T. (T.) barkeri (Hughes) 61
T. (A.) bellinus Womersley 75
Macroseius biscutatus Chant, Denmark and Baker 114
T. (A) brevispinus (Kenneth) 78
T. (A.) britannicus sp.n 87
T. (T.) burrelli sp.n. 51
T. (A.) callunae (Willmann) comb.nov 81
T. (A.) caudatus (Berlese) 86, 97
T. (T.) caudiglans Schuster 64
Proprioseius clancyi Chant 112
T. (A.) collyerae sp.n. 87
T. (T.) columbiensis sp.n. 53
T. communis (Ribaga) 103
T. communis var. *hederae* (Ribaga) 103
T. (A.) concordis sp.n. 69
T. (T.) constrictus (Garman) 55
T. (T.) contiguus Chant. 50
Phytoseius (D.) corniger Wainstein 107
T. (T.) cornus De Leon 55
T. (A.) coronatus (Fox) comb.nov 103
T. (A.) cucumeris Oudemans 78
T. curtipilis (Ribaga) 103
I. degenerans (Berlese) 110
T. (A.) desertus Chant 76
T. (A.) evansi sp.n. 99
T. (A.) exopodalis (Kennett) comb.nov. 90
T. (A.) fallacis (Garman) 74
Phytoseius finitimus Ribaga 108
T. (A.) finlandicus (Oudemans) 67
T. (A.) floridanus (Muma) comb.nov 85
T. (T.) flumenis Chant 57
T. (A.) foenalis (Berlese) 90
T. (A.) fragariae (Kennett) comb.nov 89
T. (A.) fraterculus (Berlese). 83
T. (A.) garmani nom.nov 81
T. (A.) gracilis (Garman) comb.nov 95
T. (A.) graminis (Chant) comb.nov. 89
T. (A.) grandis (Berlese) 102
T. (T.) gratus sp.n. 58
I. grovesae sp.n. 110
T. (A.) guatemalensis nom.nov. 83
T. (T.) hartlandrowei Evans 60
T. (T.) helveolus nom. nov 58
T. (T.) herbertae sp.n. 55
T. (A.) herbicolus sp.n 84
T. (A.) heveae Oudemans. 101
T. (A.) hevearum Oudemans 104
T. (A.) hexagonus (Berlese) comb.nov 103
T. (A.) hibisci sp.n. 68
S. hirsutigenus Berlese 113
Phytoseius horridus Ribaga 108
T. (T.) invectus sp.n. 60
T.(A.) irregularis Evans 70
S. isotrichus Athias-Henriot 113
T. (A.) italicus sp.n. 70
T. (A.) japonicus Ehara 80
T. (A.) jucundus sp.n. 97
T. (T.) juniperus sp.n. 61
T. (A.) krantzi nom. nov 83
T. (A.) largoensis (Muma) comb.nov 96
T. (A.) lepidus sp.n. 82
T. (A.) leucophaeus (Athias-Henriot) comb.n. 99
T. (A.) lichenis sp.n 86
T. (A.) limonicus (Garman & McGregor) comb. nov 96
T. (A.) longilaterus Athias-Henriot 79
T. (T.) longipilus Nesbitt 59
T. (A.) longispinosus Evans 74
T. (A.) longulus (Berlese) 86
Phytoseiulus macropilis (Banks) 109
Phytoseius (D.) macropilis (Banks) 107
T. (A.) magnanalis (Thor) comb.n. 105
T. (A.) marinus (Willmann) 79
T. (A.) masseei Nesbitt 75
T. (T.) mcgregori sp.n. 57
Proprioseius meridionalis Chant 111
T. (A.) meridionalis (Berlese) comb.nov 85
T. (A.) mesembrinus Dean 70
T. (A.) mexicanus (Garman) comb.nov. 92
Proprioseius mirandai De Leon 112
T. (A.) morgani Chant 85
T. (A.) multidentatus sp.n. 84
T. musci Oudemans 104
Phytoseius (P.) nahuellensis De Leon 106
T. (T.) nelsoni sp.n. 56
T. (A.) neomexicanus nom. nov 89
T. (T.) nesbitti Womersley 65
T. (A.) newsami Evans 96

T. (*A.*) *novaescotiae* sp.n. 77
T. (*A.*) *obtusus* (Koch) 90
T. (*T.*) *occidentalis* Nesbitt 59
T. (*A.*) *okanagensis* Chant 93
T. (*A.*) *oregonensis* (Garman) comb.nov. 91
T. (*A.*) *ornatus* Athias-Henriot 75
T. (*A.*) *oudemansi* sp.n. 100
T. (*A.*) *ovalis* Evans 68
T. (*A.*) *ovatus* (Garman) comb.nov. 90
T. (*A.*) *paspalivorus* De Leon 79
T. (*A.*) *peregrinus* Muma 97
T. (*A.*) *perlongisetus* (Berlese) 84
T. (*T.*) *perplexus* sp.n. 51
Phytoseiulus persimilis Athias-Henriot 109
T. (*T.*) *pilosus* sp.n. 53
T. (*T.*) *pini* Chant 53
Phytoseius (*D.*) *platypilis* sp.n. 107
Phytoseius (*P.*) *plumifer* (Canestrini and Fanzago) 106
T. polonicus (Willmann) 104
T. (*T.*) *pomi* (Parrott) 56
T. (*A.*) *potentillae* (Garman) comb.nov. 93
T. (*A.*) *primuli* sp.n. 99
T. (*A.*) *putmani* sp.n. 91
T. (*T.*) *pyri* Scheuten 64
I. quadripilis (Banks) comb.nov. 110
T. (*A.*) *rademacheri* (Dosse) comb.n. 89
T. (*T.*) *recki* Wainstein 62
T. (*A*). *reticulatus* Oudemans 76
T. (*T.*) *rhenanus* (Oudemans) 62
T. (*A.*) *robiniae* sp.n. 98
T. (*A.*) *rosellus* sp.n. 81
T. (*A.*) *sandersi* sp.n. 102
T.(*A.*) *schusteri* sp.n. 88
T. (*A.*) *scoticus* Collyer 76
T. (*A.*) *septus* (Garman) comb.nov. 92
T. (*A.*) *setatus* (Berlese)comb.n. 105
T. (*A.*) *setosus* (Muma) comb.nov. 70
T. (*A.*) *sexsetosus* (Fox) comb.nov. 103
T. (*A.*) *sextus* (Garman) comb.nov. 66
T. (*A.*) *silvaticus* sp.n. 94
T. (*A.*) *similis* (Koch) 93
S. simplex Chant 112
T. (*T.*) *singularis* Chant 61
T. (*T.*) *smithi* Schuster 49
T. (*T.*) *soleiger* (Ribaga 59
T. (*A.*) *terrestris* sp.n. 103
Typhloseiopsis theodoliticus De Leon 113
T. tiliacolis Oudemans 104
T. (*T.*) *tiliarum* Oudemans 65
T. (*T.*) *transvaalensis* (Nesbitt) 60
T. (*A.*) *tropicanus* (Garman) comb.nov. 91
T. (*T.*) *tropicus* sp.n. 54
T. (*A.*) *Tsugawai* (Ehara) comb.n. 92
T. (*A.*) *umbraticus* Chant 75
T. (*T.*) *validus* Chant 56
T. vepallidus (Koch) 104
T. (*A.*) *victoriensis* Womersley 68
T. (*T.*) *vulgaris* Ehara 64
T. (*A.*) *swoelferi* Dosse 78

LIST OF NEW SYNONYMIES

The following new synonymies are introduced in this paper:

T. citri McGregor is a synonym of *T. pini* Chant;
T. pacificus McGregor is a synonym of *T. pini* Chant;
T. kasachstanicus Wainstein is a synonym of *T. rhenanus* (Oudemans);
T. tiliae Oudemans is a synonym of *T. pyri* Scheuten;
T. (*T.*) *georgicus* Wainstein is a synonym of *T.*(*T.*) *recki* Wainstein;
T. formosus Wainstein is a synonym of *T. tiliarum* Oudemans;
T. tuberculatus Wainstein is a synonym of *T. aceri* Collyer;
T. chilenensis Dosse is a synonym of *T. ornatus* Athias-Henriot;
Phytoseiulus riegeli Dosse is a synonym of *P. persimilis* Athias-Henriot;
Amblyseius musae Garman is a synonym of *T. perlongisetus* (Berlese);
T. californicus McGregor ia a synonym of *T. marinus* (Willmann);
T. mungeri McGregor is a synonym of *T. marinus* Willmann;
Amblyseius orientalis Ehara is a synonym of *T.* (*A.*) *gracilis* (Garman).

The following new names are proposed in this paper;

T. helveolus nom. nov. for *T. floridanus* Muma;
T. garmani nom. nov. for *Amblyseiopsis limonicus* Garman;
T. guatemalensis nom. nov. for *Amblyseiopsis elongatus* Garman;
T. krantzi nom. nov. for *T. berlesei* Chant;
T. neomexicanus nom. nov. for *Amblyseiopsis reticulatus* Garman.